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AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facililties (air).

For related information see also *Astronautics*.

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Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

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For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

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For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

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Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

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55 SPACE BIOLOGY **N.A.**

Includes exobiology; planetary biology; and extraterrestrial life.

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75 PLASMA PHYSICS 2517
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For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

76 SOLID-STATE PHYSICS 2519
Includes superconductivity.
For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

77 THERMODYNAMICS AND STATISTICAL PHYSICS 2522
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL) N.A.
Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT 2525
Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE 2525
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.
For computer documentation see *61 Computer Programming and Software.*

83 ECONOMICS AND COST ANALYSIS N.A.
Includes cost effectiveness studies.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY 2526
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION 2526
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences.*

88 SPACE SCIENCES (GENERAL) N.A.

89 ASTRONOMY 2526
Includes radio, gamma-ray, and infrared astronomy; and astrometry.

90 ASTROPHYSICS 2535
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

91 LUNAR AND PLANETARY EXPLORATION 2559
Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

92 SOLAR PHYSICS 2560
Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

93 SPACE RADIATION 2561
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

GENERAL

Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

99 GENERAL N.A.

Note: N.A. means that no abstracts were assigned to this category for this issue.

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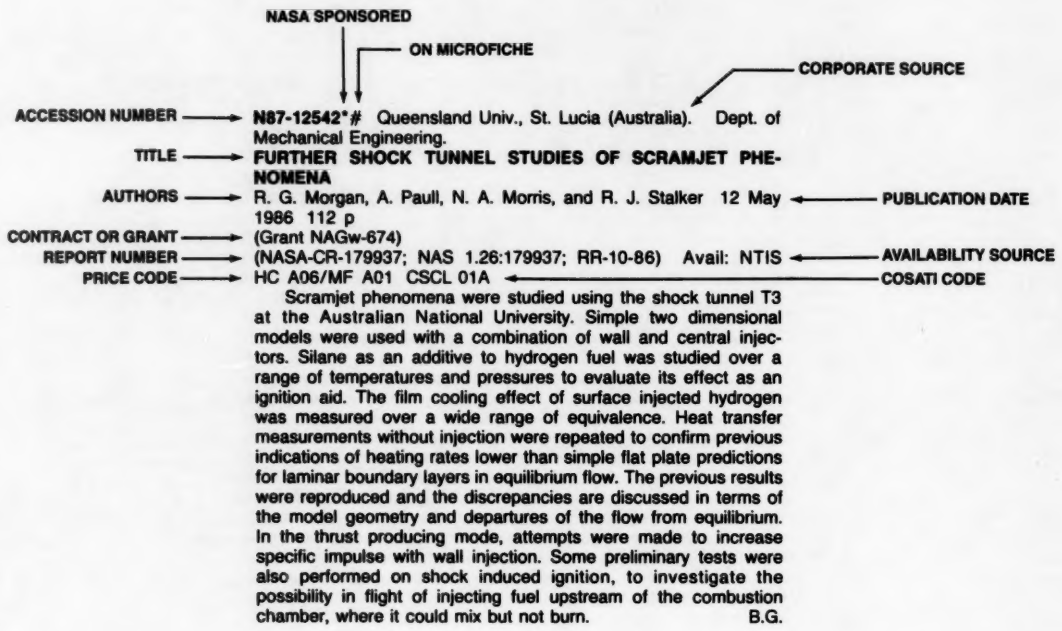
TYPICAL CITATION AND ABSTRACT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ACCESSION NUMBER
N87-12542*# Queensland Univ., St. Lucia (Australia). Dept. of Mechanical Engineering.
TITLE
FURTHER SHOCK TUNNEL STUDIES OF SCRAMJET PHENOMENA
AUTHORS
R. G. Morgan, A. Paull, N. A. Morris, and R. J. Stalker 12 May 1986 112 p
PUBLICATION DATE
CONTRACT OR GRANT
(Grant NAGw-674)
REPORT NUMBER
(NASA-CR-179937; NAS 1.26:179937; RR-10-86) Avail: NTIS
AVAILABILITY SOURCE
PRICE CODE
HC A06/MF A01 CSCL 01A
COSATI CODE
Scramjet phenomena were studied using the shock tunnel T3 at the Australian National University. Simple two dimensional models were used with a combination of wall and central injectors. Silane as an additive to hydrogen fuel was studied over a range of temperatures and pressures to evaluate its effect as an ignition aid. The film cooling effect of surface injected hydrogen was measured over a wide range of equivalence. Heat transfer measurements without injection were repeated to confirm previous indications of heating rates lower than simple flat plate predictions for laminar boundary layers in equilibrium flow. The previous results were reproduced and the discrepancies are discussed in terms of the model geometry and departures of the flow from equilibrium. In the thrust producing mode, attempts were made to increase specific impulse with wall injection. Some preliminary tests were also performed on shock induced ignition, to investigate the possibility in flight of injecting fuel upstream of the combustion chamber, where it could mix but not burn. B.G.

VOLUME 25 NUMBER 18 / SEPTEMBER 23, 1987

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERONAUTICS (GENERAL)

N87-24394* National Aeronautics and Space Administration, Washington, D.C.
AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 214)
Jun. 1987 123 p
(NASA-SP-7037(214); NAS 1.21:7037(214)) Avail: NTIS HC A07; NTIS standing order as PB86-914100, $7.00 domestic, $14.00 foreign CSCL 01A

This bibliography lists 422 reports, articles and other documents introduced into the NASA scientific and technical information system in May, 1987. Author

N87-24395# National Aerospace Lab., Amsterdam (Netherlands).
[ACTIVITIES REPORT IN AEROSPACE RESEARCH] Annual Report, 1985 [VERSLAG OVER HET JAAR 1985]
1985 111 p In DUTCH Original contains color illustrations
(B8677595; JE40110; ETN-87-99589) Avail: NTIS HC A06/MF A01

Research in flow, aircraft construction and materials, astronautics and remote sensing, applied computer sciences, environment management, and energy supply is surveyed. The technical equipment for flow studies, aircraft use and flight-mechanical investigations, construction and materials, space exploration, and remote sensing is described. A measuring, registration, and evaluation system for flight tests, and a CCD scanner for remote sensing applications are presented. International cooperation efforts are described. ESA

N87-24396* National Aeronautics and Space Administration, Washington, D.C.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 299)
Jul. 1987 47 p
(NASA-SP-7011(299); NAS 1.21:7011(299)) Avail: NTIS HC A03; NTIS standing order as PB86-912300, $8.00 domestic, $16.00 foreign CSCL 01A

This bibliography lists 96 reports, articles, and other documents introduced into the NASA scientific and technical information system in June, 1987. Author

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N87-24397*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLOW-SEPARATION PATTERNS ON SYMMETRIC FOREBODIES
Earl R. Keener Washington Jan. 1986 142 p
(NASA-TM-86016; A-9872; NAS 1.15:86016) Avail: NTIS HC A07/MF A01 CSCL 01A

Flow-visualization studies of ogival, parabolic, and conical forebodies were made in a comprehensive investigation of the various types of flow patterns. Schlieren, vapor-screen, oil-flow, and sublimation flow-visualization tests were conducted over an angle-of-attack range from 0 deg. to 88 deg., over a Reynolds-number range from 0.3X10(6) to 2.0X10(6) (based on base diameter), and over a Mach number range from 0.1 to 2. The principal effects of angle of attack, Reynolds number, and Mach number on the occurrence of vortices, the position of vortex shedding, the principal surface-flow-separation patterns, the magnitude of surface-flow angles, and the extent of laminar and turbulent flow for symmetric, asymmetric, and wake-like flow-separation regimes are presented. It was found that the two-dimensional cylinder analogy was helpful in a qualitative sense in analyzing both the surface-flow patterns and the external flow field. The oil-flow studies showed three types of primary separation patterns at the higher Reynolds numbers owing to the influence of boundary-layer transition. The effect of angle of attack and Reynolds number is to change the axial location of the onset and extent of the primary transitional and turbulent separation regions. Crossflow inflectional-instability vortices were observed on the windward surface at angles of attack from 5 deg. to 55 deg. Their effect is to promote early transition. At low angles of attack, near 10 deg., an unexpected laminar-separation bubble occurs over the forward half of the forebody. At high angles of attack, at which vortex asymmetry occurs, the results support the proposition that the principal cause of vortex asymmetry is the hydrodynamic instability of the inviscid flow field. On the other hand, boundary-layer asymmetries also occur, especially at transitional Reynolds numbers. The position of asymmetric vortex shedding moves forward with increasing angle of attack and with increasing Reynolds number, and moves rearward with increasing Mach number. Author

N87-24398# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics panel and Structures and Materials Panel.
AEROELASTICITY IN AXIAL-FLOW TURBOMACHINES. VOLUME 1: UNSTEADY TURBOMACHINERY AERODYNAMICS
Max F. Platzer, ed. and Franklin O. Carta, ed. (United Technologies Research Center, East Hartford, Conn.) Mar. 1987 276 p
(AGARD-AG-298-Vol-1; ISBN-92-835-1543-9) Copyright Avail: NTIS HC A13/MF A01

The field of unsteady turbomachinery aerodynamics is reviewed. Linearized unsteady aerodynamic theory, classical two-dimensional methods, three-dimensional flows, unsteady transonic flow, stall flutter, forced vibration, fan blade flutter, and unsteady aerodynamic measurements on rotors are among the topics discussed. For individual titles, see N87-24399 through N87-24408.

N87-24399 United Technologies Research Center, East Hartford, Conn.
LINEARIZED UNSTEADY AERODYNAMIC THEORY
Joseph M. Verdon *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 31 p Sponsored by Naval Air Systems Command and Air Force Office of Scientific Research
(For primary document see N87-24398 18-02)
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The importance, complexity and variety of the unsteady flow phenomena occurring in axial flow turbomachines; the major assumptions used in theoretical aerodynamic formulations intended for aeroelastic investigations; and the requirements placed on such formulations were reviewed. Emphases was placed on the description of linearized two-dimensional unsteady aerodynamic theories and on the derivation of a rather general linearization that accounts for the effects of blade geometry, mean blade loading and shocks and their motions on aerodynamic response to prescribed structural and areodynamic excitations. R.J.F.

N87-24400 Cambridge Univ. (England). Dept. of Engineering.
CLASSICAL TWO-DIMENSIONAL METHODS
D. S. Whitehead *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 30 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

The most important two-dimensional solutions which can be obtained by the superposition of elementary analytical solutions are presented. This has enabled cascades of flat plates to be treated up to Mach numbers at which the axial velocity becomes sonic. Singularity theory valid for incompressible flow through cascades of thick cambered blades is discussed. Author

N87-24401 Kyushu Univ., Fukuoka (Japan). Dept. of Aeronautical Engineering.
THREE-DIMENSIONAL FLOWS
Masanobu Namba *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 30 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

The objective is to outline the available theoretical methods which can predict various three-dimensional effects upon unsteady blade loadings. An attempt is made to describe typical features of three-dimensional effects revealed by those theoretical methods. Author

N87-24402 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
THREE-DIMENSIONAL FLOW
Pierre Salaun *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Trubomachinery Aerodynamics Mar. 1987 17 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

A single annular blade row with a finite number of vibrating blades which are rotating at a constant angular velocity in an infinitely long cylindrical duct is considered. The only cases considered are those where the relative velocity is either subsonic or supersonic over all of the blades. R.J.F.

N87-24403 TopExpress Ltd., Cambridge (England).
NUMERICAL METHODS FOR UNSTEADY TRANSONIC FLOW
E. Acton and S. G. Newton (Rolls-Royce Ltd., Derby, England) *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 21 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

Some of the numerical methods used in aeroelastic problems to calculate unsteady transonic flow are reviewed. Blade flutter and force response are studied. Author

N87-24404 Stevens Inst. of Tech., Hoboken, N. J. Dept. of Mechanical Engineering.
STALL FLUTTER **c08**
F. Sisto *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 11 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

A qualitative exposition of stall flutter and the closely related phenomena of choke flutter and supersonic bending stall flutter in axial flow turbomachines is given. R.J.F.

N87-24405 Purdue Univ., West Lafayette, Ind. Thermal Sciences and Propulsion Center.
UNSTEADY AERODYNAMIC MEASUREMENTS IN FLUTTER RESEARCH
Sanford Fleeter and Robert L. Jay (General Motors Corp., Indianapolis, Ind.) *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 18 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

Various aspects of unsteady aerodynamic flutter experiments were considered. Overall objectives included the validation of analysis, the development of a flutter boundary data bank, and concept investigations. Experimental modeling requirements and the applicability of high speed rotating rigs, stationary annular cascades, and two-dimensional linear cascade facilities were discussed in terms of the overall objectives. Author

N87-24406 General Motors Corp., Indianapolis, Ind. Gas Turbine Div.
UNSTEADY AERODYNAMIC MEASUREMENTS IN FORCED VIBRATION RESEARCH
Robert L. Jay and Sanford Fleeter (Purdue Univ., West Lafayette, Ind.) *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 38 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

By defining the operating environment of turbomachinery blading in terms of absolute and relative velocity fields, airfoil dynamic mode shapes, and reduced frequency ranges, the applicability of various flow facilities in establishing critical time varying aeroelastic data needed for the solution of flutter and forced vibration problems was examined. Author

N87-24407 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
UNDERSTANDING FAN BLADE FLUTTER THROUGH LINEAR CASCADE AEROELASTIC TESTING
Edmond Szechenyi *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 16 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

An attempt is made to give some insight into the causes and origins of different flutter regimes. The discussion is based on experimental data obtained in a linear cascade. For subtransonic flutter the validity of the cascade measurements is tested by comparison with actual compressor data. Author

N87-24408 Technische Hochschule, Aachen (West Germany). Inst. fuer Strahlantriebe.
UNSTEADY AERODYNAMIC MEASUREMENTS ON ROTORS
Heinz E. Gallus *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 18 p (For primary document see N87-24398 18-02)
Copyright Avail: NTIS HC A13/MF A01

A review is given of the wide variety of fluid and structural measurements used on rotors. Techniques for displacement and vibration measurement of rotor blades, for unsteady flow measurement, for unsteady blade static pressure measurement, and for flow field and rotor wake studies are discussed. Flow visualization employing Schlieren and shadowgraph techniques, gas fluorescence, holographic interferometry, and laser velocimetry are discussed. R.J.F.

N87-24409*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PERFORMANCE AND LOADS DATA FROM A HOVER TEST OF A FULL-SCALE ADVANCED TECHNOLOGY XV-15 ROTOR

Fort F. Felker, Larry A. Young, and David B. Signor Jan. 1986 359 p
(NASA-TM-86854; A-86023; NAS 1.15:86854) Avail: NTIS HC A16/MF A01 CSCL 01A

A hover test of a full-scale, composite, advanced technology XV-15 rotor was conducted at the Outdoor Aerodynamic Research Facility at Ames Research Center. The primary objective of the test was to obtain accurate measurements of the hover performance of this rotor system. Data were acquired for rotor tip Mach numbers ranging from 0.35 to 0.73. The rotor was tested with several alternate blade root and blade-tip configurations. Data are presented on rotor performance, rotor-wake downwash velocities, and rotor system loads. Author

N87-24410*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PROCEEDINGS OF THE 1985 NASA AMES RESEARCH CENTER'S GROUND-EFFECTS WORKSHOP
Kerry Mitchell, ed. Feb. 1987 448 p Workshop held at Moffett Field, Calif., 20-21 Aug. 1985
(NASA-CP-2462; A-86391; NAS 1.55:2462) Avail: NTIS HC A19/MF A01 CSCL 01A

The purpose of the workshop was to discuss the current technology base for aerodynamic ground effects and to establish directions for further research of advanced, high performance aircraft designs, particularly those concepts utilizing powered lift systems; e.g., V/STOL, ASTOVL, and STOL aircraft. Fourteen papers were presented in the following areas: suckdown and fountain effects in hover; STOL ground vortex and hot gas ingestion; and vortex lift and jet flaps in ground effect. These subject areas were chosen with regard to current activities in the field of aircraft ground effects research. For individual titles, see N87-24411 through N87-24422.

N87-24411*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
V/STOL AND STOL GROUND EFFECTS AND TESTING TECHNIQUES **c05**
R. E. Kuhn *In its* Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 1-145 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01C

The ground effects associated with V/STOL operation were examined and an effort was made to develop the equipment and testing techniques needed for that understanding. Primary emphasis was on future experimental programs in the 40 x 80 and the 80 x 120 foot test sections and in the outdoor static test stand associated with these facilities. The commonly used experimental techniques are reviewed and data obtained by various techniques are compared with each other and with available estimating methods. These reviews and comparisons provide insight into the limitations of past studies and the testing techniques used and identify areas where additional work is needed. The understanding of the flow mechanics involved in hovering and in transition in and out of ground effect is discussed. The basic flow fields associated with hovering, transition and STOL operation of jet powered V/STOL aircraft are depicted. E.R.

N87-24412*# McDonnell-Douglas Research Labs., St. Louis, Mo.
LASER DOPPLER VELOCIMETER MEASUREMENTS IN A 3-D IMPINGING TWIN-JET FOUNTAIN FLOW
K. R. Saripalli *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workship Feb. 1987 p 147-159 Previously announced in IAA as A86-10965 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

Mean velocity and turbulence measurements were conducted on the three dimensional fountain flow field generated by the impingement of two axisymmetric jets on a ground plane with application to vertical takeoff and landing (VTOL) aircraft. The basic instantaneous velocity data were obtained using a two component laser Doppler velocimeter in a plane connecting the nozzle centerlines at different heights above the ground emphasizing the jet impingement region and the fountain upwash region formed by the collision of the wall jets. The distribution of mean velocity components and turbulence quantities, including the turbulence intensity and the Reynolds shear stress, were derived from the basic velocity data. Detailed studies of the characteristics of the fountain revealed self-similarity in the mean velocity and turbulence profiles across the fountain. The spread and mean velocity decay characteristics of the fountain were established. Turbulence intensities of the order of 50% were observed in the fountain. Author

N87-24413*# Flow Research, Inc., Kent, Wash.
NUMERICAL INVESTIGATION OF V/STOL JET INDUCED INTERACTIONS
Magdi H. Rizk and Suresh Menon *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workship Feb. 1987 p 161-193 (For primary document see N87-24410 18-02)
(Contract F49620-84-C-0027)
Avail: NTIS HC A19/MF A01 CSCL 01A

Direct numerical simulation using the full three dimensional, time dependent Navier-Stokes equations is used to investigate V/STOL jet induced interactions. The objective of this numerical simulation is to compute accurately the details of the flow field and to achieve a better understanding of the physics of the flow, including the role of initial turbulence in the jet, the influence of forward motion on hover aerodynamics, the collision zone and fountain characteristics. Preliminary results are presented. Author

N87-24414*# Nielsen Engineering and Research, Inc., Mountain View, Calif.
UNSTEADY THREE-DIMENSIONAL SIMULATION OF VTOL UPWASH FOUNTAIN TURBULENCE
Robert E. Childs and David Nixon *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research center's Ground-Effects Workship Feb. 1987 p 195-206 Previously announced in IAA as A86-19753 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

Numerical simulations of a planar turbulent wall jet and a planar VTOL upwash fountain were performed. These are three dimensional simulations which resolve large scale unsteady motions in the flows. The wall jet simulation shows good agreement with experimental data and is presented to verify the simulation methodology. Simulation of the upwash fountain predicts elevated shear stress and a half velocity width spreading rate of 33% which agrees well with experiment. Turbulence mechanisms which contribute to the enhanced spreading rate are examined. Author

N87-24415*# Applied Research Lab., State College, Pa.
SUMMARY OF STOL GROUND VORTEX INVESTIGATION
Michael L. Billet and Marvin M. Walters (Naval Air Development Center, Warminster, Pa.) *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workship Feb. 1987 p 207-238 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

An experimental facility was developed in the 1.23 (48 inch) wind tunnel of the Applied Research Lab. at the Pennsylvania State Univ. to model the ground vortex. The purpose of the facility was to study the effect of various parameters on the location and characteristics of a ground vortex. An experimental investigation was conducted in the tunnel into the formation, stability and strength of the ground vortex for several flow parameters. The design of the facility, special instrumentation and results are summarized. E.R.

N87-24416*# Northrop Corp., Hawthorne, Calif. Aircraft Div.
EFFECTS OF THRUST REVERSING IN GROUND PROXIMITY
P. B. Joshi and R. V. Hughes *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's

Ground-Effects Workshop Feb. 1987 p 239-288 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

The changes in stability and control characteristics encountered by a thrust reversing aircraft during its final approach, landing, and ground roll are described. These changes include a strong pitch-up accompanied by the loss of horizontal tail and aileron control effectiveness. The magnitude of reverser induced changes in ground effect are much larger than corresponding changes in free air. Some unexpected unsteady motions exhibited in wind tunnel by an aircraft model with reversers operating in ground proximity are also described. The cause of this oscillatory behavior was determined to be an unsteady interaction between the wall jets formed by impingement of reverser jets on the ground and the on-coming free stream. Time histories of rolling moments measured by the wind tunnel balance or support system were removed and frequencies were scaled by Strouhal number to full scale. Corrected time series were used to simulate the motion of a fighter aircraft with thrust reversers in ground effect. The simulation predicted large roll angles and nose down attitude at touchdown. Some phenomena of jet attachment to solid surfaces are discussed and areas for future research are recommended.
Author

N87-24417*# McDonnell Aircraft Co., St. Louis, Mo.
STOL LANDING THRUST: REVERSER JET FLOWFIELDS
D. R. Kotansky and L. W. Glaze *In* NASA. Ames Research Center Prodeedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 289-308 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

Analysis tools and modeling concepts for jet flow fields encountered upon use of thrust reversers for high performance military aircraft are described. A semi-empirical model of the reverser ground wall jet interaction with the uniform cross flow due to aircraft forward velocity is described. This ground interaction model is used to demonstrate exhaust gas ingestion conditions. The effects of control of exhaust jet vector angle, lateral splay, and moving versus fixed ground simulation are discussed. The Adler/Baron jet-in-cross flow model is used in conjunction with three dimensional panel methods to investigate the upper surface jet induced flow field.
Author

N87-24418*# Rolls-Royce Ltd., Bristol (England). Military Installation.
THE SCALING OF MODEL TEST RESULTS TO PREDICT INTAKE HOT GAS REINGESTION FOR STOVL AIRCRAFT WITH AUGMENTED VECTORED THRUST ENGINES c07
C. J. Penrose *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 309-339 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

The difficulties of modeling the complex recirculating flow fields produced by multiple jet STOVL aircraft close to the ground have led to extensive use of experimental model tests to predict intake Hot Gas Reingestion (HGR). Model test results reliability is dependent on a satisfactory set of scaling rules which must be validated by fully comparable full scale tests. Scaling rules devised in the U.K. in the mid 60's gave good model/full scale agreement for the BAe P1127 aircraft. Until recently no opportunity has occurred to check the applicability of the rules to the high energy exhaust of current ASTOVL aircraft projects. Such an opportunity has arisen following tests on a Tethered Harrier. Comparison of this full scale data and results from tests on a model configuration approximating to the full scale aircraft geometry has shown discrepancies between HGR levels. These discrepancies although probably due to geometry and other model/scale differences indicate some reexamination of the scaling rules is needed. Therefore the scaling rules are reviewed, further scaling studies planned are described and potential areas for further work are suggested.
Author

N87-24419*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HOT GAS INGESTION: FROM MODEL RESULTS TO FULL SCALE ENGINE TESTING c07
Albert L. Johns, Thomas J. Biesiadny, and L. L. Pagel (McDonnell Aircraft Co., St. Louis, Mo.) *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 341-361 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 21E

An overview is presented of a joint NASA Lewis McDonnell Aircraft Co. Hot Gas Ingestion (HGI) test program in NASA Lewis' 9 x 15 foot Low Speed Wind Tunnel (LSWT). Advanced short takeoff vertical landing (ASTOVL) aircraft capable of operating from remote sites, damaged runways, aircraft carriers and small air-capable ships are being pursued for deployment around the turn of the century. To achieve this goal, it is important that technologies critical to this unique class of aircraft be developed. One of the ASTOVL concepts, the vectored thrust, has as its critical technology item, the potential of hot gas ingestion (which occurs during vertical flight operation while in ground effect) as a key development issue. Recognizing this need, NASA Lewis Powered Lift Section and McAir have defined a cooperative program for testing in the Lewis 9 x 15 foot LSWT. This program is described in detail.
Author

N87-24420*# Kansas Univ., Lawrence.
INVESTIGATION OF DYNAMIC GROUND EFFECT
Ray Chung Chang and Vincent U. Muirhead *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 363-393 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

An experimental investigation of dynamic ground effect was conducted in the Univ. of Kansas wind tunnel using delta wings of 60, 70, 75 deg sweep; the XB-70 wing; and the F-104A wing. Both static and dynamic tests were made. Test data were compared to other test data, including dynamic flight test data of the XB-70 and F-104A. Limited flow visualization test were conducted. A significant dynamic effect was found for highly swept delta wings.
Author

N87-24421*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE GROUND EFFECTS OF A POWERED-LIFT STOL AIRCRAFT DURING LANDING APPROACH c05
Victor C. Stevens *In its* Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 395-413 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01C

The effects of ground proximity on a powered lift STOL aircraft are presented. The data are from NASA's Quiet Short Haul Research Aircraft (QSRA) flown at landing approach airspeeds of less than 60 knots with an 80 lb/sq ft wing loading. These results show that the ground effect change in lift is positive and does significantly reduce the touchdown sink rate. These results are compared to those of the YC-14 and YC-15. The change in drag and pitching moment caused by ground effects is also presented.
Author

N87-24422*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EFFECTS OF GROUND PROXIMITY ON A LOW ASPECT RATIO PROPULSIVE WING/CANARD CONFIGURATION
V. R. Stewart (Rockwell International Corp., Columbus, Ohio.) and G. T. Kemmerly *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 415-444 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

The effect of near proximity to the ground are investigated on a low aspect ratio propulsive wing/canard concept at STOL conditions. Data were obtained on a wing/body and

wing/body/canard configuration at various heights above the ground, ranging from free air to approximately 1/4 of the mean aerodynamic chord (MAC) above the ground. The data presented and discussed include force and moment coefficients, surface pressure distributions, and downwash angles measured one MAC behind the wing. The test technique, model requirements, and special considerations required for testing these configurations are also discussed. Special model requirements included evenly distributed exit nozzle pressures along four separate nozzles of lengths of one and two feet with only one air supply to the model. Test techniques must recognize and deal with the ground boundary layer as well as the air supply pressure measurement and management. Author

N87-24423*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HELICOPTER BLADE DYNAMIC LOADS MEASURED DURING PERFORMANCE TESTING OF TWO SCALED ROTORS
John D. Berry Jul. 1987 49 p
(DA Proj. 1L1-62209-AH-76)
(NASA-TM-89053; L-16245; NAS 1.15:89053; AVSCOM-TM-87-B-7) Avail: NTIS HC A03/MF A01 CSCL 01A

A test to determine the performance differences between the 27-percent-scale models of two rotors for the U.S. Army AH-64 helicopter was conducted in the Langley 14- by 22-Foot Subsonic Tunnel. One rotor, referred to as the baseline rotor, simulated the geometry and dynamic characteristics of the production baseline rotor, and the other rotor, referred to as the advanced rotor, was designed to have improved hover performance. During the performance test, the dynamic pitch-link forces and blade bending and torsion moments were also measured. Dynamic data from the forward flight investigation are reduced and presented. The advanced blade set was designed to have dynamic characteristics similar to those of the baseline rotor so that test conditions would not be limited by potential rotor instability and blade resonances, and so that the measured performance increments could be considered to be due purely to aerodynamic causes. Data show consistent trends with advance ratio for both blade sets with generally higher oscillatory loads occurring for the advanced blade set when compared with the baseline blade set. Author

N87-24424 Colorado Univ., Boulder.
NUMERICAL OPTIMIZATION DESIGN OF TRANSONIC AIRFOILS Ph.D. Thesis
Muh-Sheng Chen 1986 209 p
Avail: Univ. Microfilms Order No. DA8706407

A computationally efficient and versatile procedure for the optimum design of transonic airfoils at given operating Mach number and lift coefficient was developed. The design tool is formed by coupling a reliable and efficient airfoil code, GRUMFOIL, with an unconstrained numerical optimization program. Only the two-dimensional transonic airfoil designs utilizing the computed drag minimization as design objectives are demonstrated, but this technique can also be applied to minimize or maximize any desired design objective which can be precisely calculated from the chosen objective code. A trade-off study was first made to examine a variety of airfoil shape perturbation methods, and an optimal shape perturbation technique was chosen after comparing the results. Four airfoil shapes, included RAE 2822, NACA 65(sub 1)012, NACA 0012, and a modified NACA 0012, were selected as the baseline airfoils to be optimized. Dissert. Abstr.

N87-24425 Colorado Univ., Boulder.
POTENTIAL FLOW ANALYSIS OF UNSTEADY JOUKOWSKI AIRFOIL IN THE PRESENCE OF DISCRETE VORTICES Ph.D. Thesis
Quen-Yaw Sheen 1986 125 p
Avail: Univ. Microfilms Order No. DA8706450

The vertical flow around a Joukowski airfoil in unsteady motion was simulated and analyzed. The fluid medium was assumed to be an incompressible potential flow and the superposition principle was used to synthesize the entire flow field. Analyses are based on a formulation for the translational and rotational plane motion of an airfoil in a fluid volume, which is unbounded in all directions and at rest at infinity. The mathematical problem is to be solved by a combination of the conformal mapping method and a numerical procedure. The pressure forces on the airfoil in the vortical flow are computed by the application of Cauchy's integral for unsteady motion in a moving reference frame. The unsteady forces are determined by means of a computer code that calculates the time history of the lift, drag, and moment arising from the unsteady flow phenomena. The following unsteady flow phenomena were studied numerically: the vortices shed by an airfoil in unsteady motion; the dynamical effects on an oscillating airfoil with a free vortex in its vicinity; and the vortices shedding periodically from an inclined flat plate. Dissert. Abstr.

N87-24426 Princeton Univ., N. J.
COMPUTATION OF UNSTEADY TRANSONIC FLOWS OVER MOVING AIRFOILS Ph.D. Thesis
V. Venkatakrishnan 1987 159 p
Avail: Univ. Microfilms Order No. DA8704598

Three numerical methods for the solution of the Euler equations for flows past a moving airfoil are developed and compared. The finite volume scheme is used to spatially discretize the integral form of the Euler equations for a moving domain. The first method uses dissipative terms constructed according to the theory of Total Variation Diminishing (or TVD) schemes. The second method utilizes dissipative terms constructed from second and fourth differences in the dependent variables. The third method uses an LU implicit scheme with dissipative terms constructed according to the TVD theory. Nonreflecting boundary conditions are derived in the farfield allowing for the use of a moving mesh. It is shown that the TVD schemes yield excellent results at the expense of more CPU time in comparison with the non-TVD scheme. The solutions are non-oscillatory, and the shocks are captured very well. The comparisons with experimental data for the unsteady airfoil calculations are uniformly good. It is anticipated that the finite volume scheme, with or without the TVD option, should make three dimensional unsteady flow simulations feasible.
Dissert. Abstr.

N87-24427 Florida Univ., Gainesville.
A NUMERICAL INVESTIGATION OF FLOW SEPARATION ON A THREE-CALIBER TANGENT OGIVE Ph.D. Thesis
Leslie Anne Yates 1986 118 p
Avail: Univ. Microfilms Order No. DA8704233

Laminar solutions for crossflow separation on a three-caliber tangent ogive were computed with the parabolized Navier-Stokes code. Adaptations were made to the gridding scheme of the code to minimize oscillations and to improve the resolution of the solutions. Solutions were obtained for Mach 2.0 at 10 and 15 degree angles of attack. Convergence lines were determined by visual inspection of the limiting streamline pattern. The dependency of the location of the convergence line upon the angle of attack and the Reynolds number agreed with experimental data. Also, the pressure distributions showed good agreement with available data. The best indication of separation was given by the behavior of streamtubes that encircled the body. These streamtubes initially were chosen to lie well within the boundary layer. They developed bumps and then folds as the streamlines converged. These folds elongated, moved away from the body, and eventually folded up. These folds widened appreciably near the surface. This widening, along with the behavior of the other flow variables, made it impossible to define one separation line. Instead, separation appeared to involve extended regions of the flow. Dissert. Abstr.

N87-24428# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
COUPLING ITERATION METHOD LINKING AERODYNAMIC FIELDS WITH PERIODIC DYNAMIC FIELDS [METHODE DE COUPLAGE ITERATIF ENTRE LES CHAMPS AERODYNAMIQUE ET DYNAMIQUE PERIODIQUES]
C. T. Tran Aug. 1986 25 p In FRENCH

(Contract STPA-85-91-015)
(ONERA-RT-19/3239-RY-054-R; ETN-87-99622) Avail: NTIS HC A02/MF A01

The aeromechanical coupling found in the motion of helicopter rotor blades is studied. The general aeroelasticity equations are solved by iteration. The introduction of a simplified aerodynamic model and of optimization procedures allow minimization of the perturbation terms to accelerate the convergence. Test cases are solved and the results are comparable to those obtained by other methods. ESA

N87-24429# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
RUNGE-KUTTA FINITE-VOLUME SIMULATION OF LAMINAR TRANSONIC FLOW OVER A NACA 0012 AIRFOIL USING THE NAVIER-STOKES EQUATIONS
Bernhard Mueller and Arthur Rizzi 14 Nov. 1986 71 p Sponsored by the Swedish Board for Technical Development
(FFA-TN-1986-60; ETN-87-99782) Avail: NTIS HC A04/MF A01

For the solution of the compressible Navier-Stokes equations, a finite-volume space discretization of the viscous fluxes is presented. The gradients of the stress tensor are approximated in the cells by means of surface integrals along the cell boundaries. Similar to the inviscid fluxes, the viscous fluxes over the cell interfaces are evaluated by the arithmetic averages of their values in adjacent cells. A linear stability condition is derived for the local time steps of the three stage explicit Runge-Kutta method used for time discretization. Employing a 257x65 O-mesh generated by transfinite interpolation, the method is verified for laminar transonic flow at Reynolds numbers of 0(100) over a NACA0012 airfoil and compared with 193x65 C-mesh results of an implicit finite-difference scheme. The C-mesh is recommended for viscous flow near the trailing edge. ESA

N87-24430# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
VORTEX INTERACTION ON A CANARD-WING CONFIGURATION Final Report, Oct. 1982 - Mar. 1985
Wladimiro Calarese Oct. 1986 265 p
(AD-A179718; AFWAL-TR-86-3100) Avail: NTIS HC A12/MF A01 CSCL 01A

This experiment studies the interaction of vortices shed by the canard and wing's leading edges, and their effect on the aircraft aerodynamic characteristics. A close-coupled canard-wing configuration was selected and tested in different wind tunnels and at different conditions. Tunnel and model size effects, Mach number, angle of attack, and spanwise blowing effects on the vortex interaction were analyzed. Intrusive (hot wires) and non-intrusive (laser doppler velocimeters) data acquisition techniques were used and compared to enhance the reliability of the results. Flow visualization by tufts, oil, and laser light sheets were employed. Mean velocities, vortex turbulence intensities, and Reynolds stresses obtained for different conditions were compared and found to be generally consistent. Mach number, wind tunnel, and model size effects were in general small. Turbulence intensities and stresses increased with angles of attack. Spanwise blowing produced a small favorable effect. The use of a coplanar canard produced a small favorable interaction between the leading edge vortices, while the off-set canard produced a considerable increase in the lift/drag ratio. GRA

N87-24431# Tennessee Univ. Space Inst., Tullahoma.
INVESTIGATION OF NON-SYMMETRIC JETS IN CROSS FLOW (DISCRETE WING TIP JET EFFECTS) Final Report
J. M. Wu, A. D. Vakili, and F. M. Yu Dec. 1986 98 p
(Grant AF-AFOSR-0114-84)
(AD-A179783; UTSI-86-13; AFOSR-87-0543TR) Avail: NTIS HC A05/MF A01 CSCL 20D

Asymmetric jets in cross flow provide complex interacting flow fields which contain many vortices. Four different cross section geometries were studied and compared with a circular cross section jet with the same exit area. Various flow visualization techniques were used and four major vortices were identified. GRA

N87-24432*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STATIC INTERNAL PERFORMANCE OF A TWO-DIMENSIONAL CONVERGENT-DIVERGENT NOZZLE WITH THRUST VECTORING
E. Ann Bare and David E. Reubush Jul. 1987 115 p
(NASA-TP-2721; L-16240; NAS 1.60:2721) Avail: NTIS HC A06/MF A01 CSCL 01A

A parametric investigation of the static internal performance of multifunction two-dimensional convergent-divergent nozzles has been made in the static test facility of the Langley 16-Foot Transonic Tunnel. All nozzles had a constant throat area and aspect ratio. The effects of upper and lower flap angles, divergent flap length, throat approach angle, sidewall containment, and throat geometry were determined. All nozzles were tested at a thrust vector angle that varied from 5.60 tp 23.00 deg. The nozzle pressure ratio was varied up to 10 for all configurations. Author

N87-24433*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MULTIAXIS CONTROL POWER FROM THRUST VECTORING FOR A SUPERSONIC FIGHTER AIRCRAFT MODEL AT MACH 0.20 TO 2.47
Francis J. Capone and E. Ann Bare Jul. 1987 264 p
(NASA-TP-2712; L-16213; NAS 1.60:2712) Avail: NTIS HC A12/MF A01 CSCL 01A

The aeropropulsive characteristics of an advanced twin-engine fighter aircraft designed for supersonic cruise have been studied in the Langley 16-Foot Tansonic Tunnel and the Lewis 10- by 10-Foot Supersonic Tunnel. The objective was to determine multiaxis control-power characteristics from thrust vectoring. A two-dimensional convergent-divergent nozzle was designed to provide yaw vector angles of 0, -10, and -20 deg combined with geometric pitch vector angles of 0 and 15 deg. Yaw thrust vectoring was provided by yaw flaps located in the nozzle sidewalls. Roll control was obtained from differential pitch vectoring. This investigation was conducted at Mach numbers from 0.20 to 2.47. Angle of attack was varied from 0 to about 19 deg, and nozzle pressure ratio was varied from about 1 (jet off) to 28, depending on Mach number. Increments in force or moment coefficient that result from pitch or yaw thrust vectoring remain essentially constant over the entire angle-of-attack range of all Mach numbers tested. There was no effect of pitch vectoring on the lateral aerodynamic forces and moments and only very small effects of yaw vectoring on the longitudinal aerodynamic forces and moments. This result indicates little cross-coupling of control forces and moments for combined pitch-yaw vectoring. Author

N87-24434*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CALCULATION OF EXTERNAL-INTERNAL FLOW FIELDS FOR MIXED-COMPRESSION INLETS
W. J. Chyu, T. Kawamura, and D. P. Bencze Oct. 1986 23 p Presented at the 1st World Congress on Computational Fluid Mechanics, Austin, Tex., 22-26 Sep. 1986
(NASA-TM-88362; A-86409; NAS 1.15:88362) Avail: NTIS HC A02/MF A01 CSCL 01A

Supersonic inlet flows with mixed external-internal compressions were computed using a combined implicit-explicit (Beam-Warming-Steger/MacCormack) method for solving the three-dimensional unsteady, compressible Navier-Stokes equations in conservation form. Numerical calculations were made of various flows related to such inlet operations as the shock-wave intersections, subsonic spillage around the cowl lip, and inlet started versus unstarted conditions. Some of the computed results were compared with wind tunnel data. Author

N87-24435*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUMERICAL SIMULATIONS OF UNSTEADY, VISCOUS, TRANSONIC FLOW OVER ISOLATED AND CASCADED AIRFOILS USING A DEFORMING GRID
Dennis L. Huff Jun. 1987 16 p Presented at the 19th Fluid Dynamics, Plasma Dynamics and Lasers Conference, Honolulu, Hawaii, 8-10 Jun. 1987; sponsored by AIAA
(NASA-TM-89890; E-3532; NAS 1.15:89890; AIAA-87-1316)
Avail: NTIS HC A02/MF A01 CSCL 01A

A compressible, unsteady, full Navier-Stokes, finite difference code was developed for modeling transonic flow through two-dimensional, oscillating cascades. The procedure introduces a deforming grid technique to capture the motion of the airfoils. Results using a deforming grid are presented for both isolated and cascaded airfoils. The load histories and unsteady pressure distributions are predicted for the NASA 64A010 isolated airfoil and compared with existing experimental data. Results show that the deforming grid technique can be used to successfully predict the unsteady flow properties around an oscillating airfoil. The deforming grid technique was extended for modeling unsteady flow in a cascade. The use of a deforming grid simplifies the specification of boundary conditions. Unsteady flow solutions similar to the isolated airfoil predictions are found for a NACA 0012 cascade with zero interblade phase angle and zero stagger. Experimental data for these cases are not available for code validation, but computational results are presented to show sample predictions from the code. Applications of the code to typical turbomachinery flow conditions will be presented in future work.
Author

N87-24436# Cambridge Univ. (England). Dept. of Engineering.
ASSESSMENT OF THE USE OF COLD GAS IN A WINDTUNNEL TO INVESTIGATE THE INFLUENCE OF THERMAL EFFECTS ON THE DISPERSION OF LNG VAPOUR CLOUDS
R. E. Britter 1987 64 p
(CUED/A-Aero/TR14; ISSN-0309-7293) Avail: NTIS HC A04/MF A01

The accidental spillage of liquefied natural gas (LNG) from sea-going transport vessels or land storage tanks may lead to clouds of a cold gas of lower molecular weight than the ambient air. The size of the cloud out to the lower flammability limit and the distance travelled by the cloud from the source are required for estimation of the potential hazard posed. The possibility of using cold gases in a wind tunnel to correctly model heat transfer to the plume and subsequent plume density changes was assessed. A literature survey of the previous modeling of dense-gas dispersion including heat transfer effects was summarized. The scaling laws for the physical modeling of the dispersion of dense gases in the absence of heat transfer effects and in the presence of heat transfer effects are developed. As a result of the scaling laws developed it is found that the modeling of flows in which free convective heat transfer is important at full-scale is not possible. The application of the scaling laws to possible release scenarios is undertaken. When forced convection heat transfer is dominant at full-scale physical modeling is feasible. However, the resulting model will have heat transfer dominated by free convection, and, therefore, be unacceptable. B.G.

N87-24478# Rockwell International Corp., Los Angeles, Calif. Aircraft Operations.
UNSTEADY INLET DISTORTION CHARACTERISTICS WITH THE B-1B
C. J. MacMiller and W. R. Haagenson *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 17 p
(For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

N87-24479# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
EXPERIMENTAL DETERMINATION OF THE TRANSFER FUNCTION OF AN AXIAL COMPRESSOR TO DISTORTED INLET FLOW [DETERMINATION EXPERIMENTALE DES LOIS DE TRANSFERT DE PERTURBATIONS A LA TRAVERSEE D'UN COMPRESSEUR AXIAL]
Jacques Huard *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 11 p In FRENCH; ENGLISH summary Original language document was announced in IAA as A87-21025 (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N87-24437# Sandia National Labs., Albuquerque, N. Mex.
A NEW RECOVERY PARACHUTE SYSTEM FOR THE F111 AIRCRAFT CREW ESCAPE MODULE Status Report
D. W. Johnson 1986 8 p
(Contract DE-AC04-76DP-00789)
(DE87-000973; SAND-86-0685) Avail: NTIS HC A02/MF A01

A new recovery parachute system for the F-111 aircraft crew escape module has been designed. Six proof-of-design tests were conducted to determine if it is feasible to meet the requirements for a replacement recovery parachute system. The design of the proposed system is presented and the results of the tests discussed.
DOE

N87-24438# National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
AIRCRAFT ACCIDENT REPORT: MIDWEST EXPRESS AIRLINES, INC., DC-9-14, N100ME, GENERAL BILLY MITCHELL FIELD, MILWAUKEE, WISCONSIN, SEPTEMBER 6, 1985
3 Feb. 1987 106 p
(PB87-910401; NTSB-AAR-87-01) Avail: NTIS HC A06/MF A01 CSCL 01C

At 1521 c.d.t. on 6 Sept. 1985, Midwest Express Airlines, Inc., Flight 105, a McDonnell-Douglas DC-9-14 airplane, crashed at the edge of a wooded area about 1,680 feet from the end of runway 19R shortly after takeoff from Mitchell Field, Milwaukee, Wisconsin. The weather was clear with visibility 10 miles. During the initial climb, about 450 feet above ground level (a.g.l.) there was a loud noise and a loss of power associated with an uncontained failure of the 9th and 10th stage high pressure compressor spacer of the right engine. Flight 105 continued to climb to about 700 feet a.g.l. and then rolled to the right, when the airplane entered an accelerated stall, control was lost, and the airplane crashed. The aircraft was destroyed by impact forces and postcrash fire. The pilot, the first officer, both flight attendants, and all 27 passengers were fatally injured. The National Transportation Safety Board determines that the probable cause of this accident was the flightcrew's improper use of flight controls in response to the catastrophic failure of the right engine during a critical phase of flight, leading to an accelerated stall and loss of control. Author

N87-24439# National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
AIRCRAFT ACCIDENT REPORT: MIDAIR COLLISION OF NABISCO BRANDS, INC., DASSAULT FALCON, DA50, N784B AND AIR PEGASUS CORPORATION, PIPER ARCHER, PA28-181, N1977H, FAIRVIEW, NEW JERSEY, NOVEMBER 10, 1985
4 May 1987 101 p
(PB87-910405; NTSB-AAR-87-05) Avail: NTIS HC A06/MF A01 CSCL 01C

On November 10, 1985 a Dassault Falcon, DA50 jet and a Piper Archer, PA28-181 collided about 1,500 feet over the towns of Fairview and Cliffside Park, New Jersey. The DA50 was cleared for a standard instrument approach procedure in visual meteorological conditions and was in a left turn to position itself on the downwind leg to runway 19 at the Teterboro Airport, and the PA28 was transiting the airport traffic area from west to east when they collided. Both planes had been in radio contact with the control tower. The National Transportation Safety Board determines that the probable cause of the accident was a breakdown in air traffic control coordination which resulted in an air traffic conflict and the inability of the DA50 flightcrew to see and avoid the other aircraft due to: (1) an erroneous and inadequate traffic advisory, and (2) the physiological limitations of human vision and reaction time at night. Air traffic control management contributed to the accident by failing to insure that controllers were following prescribed procedures and by failing to recognize and correct operational deficiencies. M.G.

N87-24440# Sandia National Labs., Albuquerque, N. Mex. Exploratory Batteries Div.

TRANSPORTATION CONTAINER FOR Li/SO2 BATTERIES ON PASSENGER AIRCRAFT

Samuel C. Levy 1987 4 p Presented at Lithium '87, Niagara Falls, N.Y., 23 Jun. 1987

(Contract DE-AC04-76DP-00789)

(DE87-008653; SAND-87-1026C; CONF-870699-1) Avail: NTIS HC A02/MF A01

A surplus USN 40 mm ammunition can was subjected to a variety of tests. Pressure tests were carried out with nitrogen gas, followed by the venting of actual Li/SO2 cells and batteries inside the can. A fire test was also conducted on a can packed with 10 each 10-cell batteries surrounded by vermiculite. Test results indicate the US Navy (USN) 40-mm ammunition can is suitable as a shipping container for Li/SO2 batteries on passenger aircraft. To provide a further measure of safety, a sulfur dioxide getter was incorporated into the can. Studies indicated a commercial material, ASC carbon, is suitable for this purpose. The granular material was packaged in porous paper desiccant bags and placed in the can with the batteries and vermiculite. The batteries were vented inside the sealed can and the internal pressure monitored. Pressure returned to normal within several minutes, indicating that this arrangement should prevent sulfur dioxide (SO2) gas from leaking into the airplane in the event of multiple battery ventings during flight. DOE

N87-24441# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de la Physique Generale.

ELECTROMAGNETIC PERTURBATIONS CREATED ONBOARD AIRCRAFT BY DIRECT OR CLOSE LIGHTNING Final Report [PERTURBATIONS ELECTROMAGNETIQUES CREEES SUR UN AERONEF PAR UN FOUDROIEMENT DIRECT OU DE PROXIMITE]

G. Labaune, J. P. Moreau, V. Gobin, and F. Issac Oct. 1986 112 p In FRENCH

(Contract DRET-85-001)

(ONERA-RF-15/7234-PY; ETN-87-99621) Avail: NTIS HC A06/MF A01

The effects of long (several meters) electric discharges simulating lightning were studied in laboratory to prepare an experiment that was carried out in flight. The electromagnetic fields generated by simulated or real lightning were measured. A large amount of information was obtained, and is presented. ESA

N87-24442# Naval Research Lab., Washington, D. C.

VECTOR ELECTRIC FIELDS MEASURED IN A LIGHTNING ENVIRONMENT

R. V. Anderson and J. C. Bailey 7 Apr. 1987 104 p

(AD-A180012; NRL-MR-5899) Avail: NTIS HC A06/MF A01 CSCL 04A

The measurement of vector electric fields from an aircraft which is struck by lightning can provide information on lightning initiation and triggering processes. Calibration of the aircraft to determine geometric field enhancements and to separate the vector components, although difficult, has been accomplished. Data from 31 strikes in the summer of 1985 are presented in three formats. The raw fields measured at the four field meters are presented both to indicate proper operation and because strikes to the wing tips may be strongly related to the local field at the wing tips. The three cartesian vector components of field and the aircraft voltage (with respect to its immediate environment) are next shown followed finally by an azimuth-elevation-magnitude presentation which appears useful for triggering studies. Author (GRA)

N87-24443# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.

AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 15, 1985 ACCIDENTS

3 Feb. 1987 223 p

(PB87-916901; NTSB/AAB-87/01) Avail: NTIS HC A10/MF A01; also available on subscription, North American Continent HC $185.00/year; all others write for quote CSCL 01C

This publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year I985. Approximately 200 General Aviation and Air Carrier accidents are described, representing a random selection. The publication is issued irregularly, normally eighteen times each year. The brief Format presents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-24444*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ROTORCRAFT-BASED EMERGENCY MEDICAL SERVICES IN THE CARIBBEAN BASIN

R. W. Smith (Puerto Rico Univ., San Juan.) and L. R. Alton Jul. 1987 26 p

(NASA-TM-89424; A-87092; NAS 1.15:89424) Avail: NTIS HC A03/MF A01 CSCL 01C

There is a pressing need for improved health care in general and emergency health care in particular throughout the Caribbean Basin. The importance of rotorcraft as an integral part of the needed system of emergency medical care in the region was investigated. Many of the larger countries in the region currently have the needed infrastructure to implement a national system of rotorcraft-based emergency medical centers within their borders. By helping to establish a system of rotorcraft based health care centers in strategic locations in the Lesser Antilles, the U.S. can assist the islands of the region by demonstrating the concept and establishing a potential training site for the other larger countries of the region. There is sufficient demand for rotorcraft based emergency health care within the Lesser Antilles to locate one center on the island of Puerto Rico and another one of the southern-most islands. With the use of fixed wing aircraft or long range helicopters, the two rotorcraft based centers could provide the region with rapid and efficient emergency health care. The superior speed and range of the XV-15 Tilt Rotor aircraft make it an attractive possibility for emergency transport and rescue in this region. Author

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N87-24613# Joint Publications Research Service, Arlington, Va.

SYNTHESIS OF DEVICES FOR OPTIMAL PROCESSING OF RADIO PULSE SIGNALS IN LONG-RANGE RADIO NAVIGATION SYSTEMS Abstract Only

P. P. Filatov *In its* USSR Report: Electronics and Electrical

Engineering 8 Apr. 1987 p 5 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 16-19 Original language document was announced in IAA as A87-15563 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24614# Joint Publications Research Service, Arlington, Va.
MEASURING INSTRUMENTS FOR RADIO NAVIGATION BASED ON SERIES K588 MICROPROCESSOR SETS Abstract Only
G. N. Gromov, V. V. Gavrishchuk, R. V. Drozdov, Yu. T. Krivoruchko, B. V. Ponomarenko, and L. I. Chukanov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 6-7 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 77-80 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24762# New Brunswick Univ., Fredericton. Geodetic Research Lab.
GLOBAL POSITIONING SYSTEM (GPS) POSITIONING TECHNIQUES FOR MOVING SENSORS
Alfred Kleusberg *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 201-205 Sponsored by the Canadian Natural Sciences and Engineering Research Council (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24763# Stuttgart Univ. (West Germany). Inst. for Navigation.
APPLICATION OF GLOBAL POSITIONING SYSTEM (GPS) RECEIVERS FOR EARTH OBSERVATION
Ph. Hartl and W. Schoeller *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 207-214 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24764# Stuttgart Univ. (West Germany). Inst. for Navigation.
COORDINATE TRANSFORMATION PROCEDURES FOR GLOBAL POSITIONING SYSTEM (GPS) ATTITUDE CONTROL
Ph. Hartl and A. Wehr *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 215-226 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.* For land transportation vehicles see *85 Urban Technology and Transportation.*

N87-24445# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
INTEGRATED DESIGN OF ADVANCED FIGHTERS
Loughton, England May 1987 213 p Lectures held in London, England, 1-2 Jun. 1987; in Lisbon, Portugal; and in Los Angeles, Calif., 23-24 Jun. 1987
(AGARD-LS-153; ISBN-92-835-1552-8) Copyright Avail: NTIS HC A10/MF A01

A general overview of the state of the art in modern fighter design is presented, with an introduction to the innovations of computer aided design evaluation to both preliminary design and the final optimization of the various design compromises. After the introduction reviewing the evolution of the modern fighter aircraft, the various stages of the total design problem is developed. The integration of requirements into the preliminary configuration of the design is followed by discussions of modern design techniques that are currently used to assess and validate the evolving configuration. The overall integrations process as applied to various current design challenges are considered including multi-role aircraft, shipborne operators and VSTOL and STOVL concepts. For individual titles, see N87-24446 through N87-24454.

N87-24446# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
INTEGRATION OF AERODYNAMIC, PERFORMANCE, STABILITY AND CONTROL REQUIREMENTS INTO THE DESIGN PROCESS OF MODERN UNSTABLE FIGHTER AIRCRAFT CONFIGURATIONS
G. Wedekind and P. Mangold *In* AGARD Integrated Design of Advanced Fighters May 1987 20 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

Already in the early design stage of a modern fighter aircraft development with usually unstable basic characteristics in pitch, a well balanced compromise between optimum performance and excellent handling qualities has to be found. This compromise must be based on sufficient margins for stability and control, maneuverability in terms of agility and economic aspects which usually are in contradiction to pure performance requirements as for example sustained/instantaneous turn rates and high specific excess power. Reasonable criteria deducted from flight mechanical and control law design point of view are discussed, which lead straight ahead towards a set of desirable longitudinal and lateral characteristics for the basic unaugmented aircraft. These requirements impose remarkable constraints for the aerodynamic design of a fighter and its elements like wing planform, strakes, vertical fins and horizontal tail size and location. The problems and possibilities to stay within the reasonable flight mechanical limits are demonstrated. Author

N87-24447# Northrop Corp., Hawthorne, Calif. Flight Control Engineering.
SIMULATION AS A FIGHTER DESIGN TOOL
J. L. Lockenour *In* AGARD Integrated Design of Advanced Fighters May 1987 34 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

Simulation has been playing a growing role in the development of fighter aircraft weapon systems. In the 6o's and early 70's simulation was almost exclusively the tool of the engineers responsible for the flight control and flying qualities of the airplane. However, in the last 10 to 15 years, simulation has seen an ever increasing usage for tactics, crew workload and mission avionics assessment. The current status of real time, pilot-in-the-loop flight simulation is reviewed. Examples are presented of simulators as is a brief discussion of the components of a flight simulator with emphasis on the features of importance to the user. Fidelity as it relates to the perception of the pilot and his task performance is discussed. Data is given on the motion and visual requirements. Key topics are also presented in experimental design including task selection, pilot factors and data collection. An enumeration of technology improvements already on the horizon which are expected to make a major impact on simulation is also given. Author

N87-24448# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Div.
FLIGHT TESTING OF FIGHTER AIRCRAFT
A. Knaus and K. H. Burger *In* AGARD Integrated Design of Advanced Fighters May 1987 21 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

A realistic overall picture about flight testing of fighter aircraft today and trends for the future is given. It is shown whether, where and to what extent flight testing is and will be necessary. Especially the implications of advanced fighter aircraft concepts on the test program are discussed regarding the high technology standard of the complete weapon system and the operational

requirements. It is concluded that best equipped facilities together with a well organized management are mandatory. The introduction of up-to-date scientific computer systems and the development of new software seems to be a permanent requirement to handle the streams of data which confront the flight test engineer. Early plannings and perparations are required to integrate as many tasks as possible per flight in order to save expensive flying time. Finally, an overview of flight test disciplines is given. It is shown that flight test is an universal discipline. Consequently areas of main test effort only and corresponding test methods to be applied are discussed in more detail. Author

N87-24449# British Aerospace Aircraft Group, Kingston-upon-Thames (England).
CARRIAGE OF EXTERNAL STORES
Clifford L. Bore *In* AGARD Integrated Design of Advanced Fighters May 1987 23 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

The main interactions between the external stores and fighter aircraft as a whole are considered. Since the context is that of fighter design, the understanding of the magnitude of those efforts which can be chosen by designers is concentrated on. The factors affect the overall value of a fighter airforce as a whole, so that the sensitivity of value to these factors can be appreciated. Then the influence of the separate factors is considered: drag and other installed forces, trajectory testing in wind tunnels, stability and flutter, agility, and airframe/store integration. Author

N87-24450# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
DESIGN OPTIMIZATION FOR A FAMILY OF MULTI-ROLE COMBAT AIRCRAFT
Jean-Claude Hironde *In* AGARD Integrated Design of Advanced Fighters May 1987 23 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

The future multi-role combat aircraft design process is used as an example. At the early stage of the design, requirements of the French Air Force and Navy and other potential customers are studied very closely. Then the main technological improvements, from the existing aircraft, that are needed to meet these requirements are clearly defined. The improvements are achieved by an optimization process carried throughout each and all aircraft design disciplines, involving an intensive use of the very large range of design and tests tools available from the aircraft company and state research establishments. Because of the numerous technical innovations which will be introduced in the future combat aircraft, an in-flight demonstration aircraft was judged necessary. The RAFALE demonstration aircraft, and the evolution into a future family of multi-role specific versions, is presented. Author

N87-24451# McDonnell Aircraft Co., St. Louis, Mo. Aircraft Engineering.
DESIGN OPTIMIZATION OF FIGHTER AIRCRAFT
D. D. Snyder *In* AGARD Integrated Design of Advanced Fighters May 1987 20 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

The explosion of digital computation capability over the last 30 years has transformed the military aircraft design process, and provided unprecedented opportunity for true optimization of selected configurations prior to production commitment. To date, this revolution has worked primarily to reduce risk in aircraft development. Today's new aircraft flies as expected, without unforeseen handling quirks or instability, and exploration of most, if not all the flight envelope is possible on the first flight. Digital flight simulation, sophisticated wind tunnel test techniques, and performance, structural and thermal modeling all combine to elevate confidence in a new design to a very high level. Another, as yet unrealized benefit is an enormous potential improvement in productivity and efficiency, and therefore cost, of the aircraft design and manufacturing process. Insight is provided into the modern aircraft development process from the perspective of a designer and builder of high performance military fighter, McDonnell Aircraft Co. Author

N87-24452# British Aerospace Aircraft Group, Kingston-upon-Thames (England).
V/STOL AND STOVL FIGHTER DESIGN
Clifford L. Bore *In* AGARD Integrated Design of Advanced Fighters May 1987 20 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

A wide range of basing concepts, including dispersed land bases, small and very small ships, ski jump and Skyhook, are reviewed. The design of STOVL fighter aircraft is examined, starting from consideration of the engine and nozzles system, which is the heart of jet powered STOVL fighters. This leads to consideration of the nature of the aerodynamics of vertical landing, such as hot gas ingestion, jet induced suck-down and the ground/jets fountain. Then the special features of air intakes design are considered, followed by the special considerations of lifting-surface design. Finally, the special features of thrust vectoring in forward flight (VIFF), are considered. Author

N87-24453# Societe pour l'Equipment des Vehicules, Gosselies (Belgium).
ADVANCED FIGHTER DESIGN: OPERATIONAL EXPERIENCE AND FUTURE REQUIREMENTS
D. Agneessens *In* AGARD Integrated Design of Advanced Fighters May 1987 14 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

The possibilities of the F84F, Mirage 5, the F104G and the F-16 are compared. The deficencies that they show for the mission for which they are employed are examined. Before these aircraft are analyzed, it is necessary to state in what role each they are employed. To do this, the requirements have to be considered. These are mostly imposed by NATO, but national requirements could also be considered. Due to the large variety of missions to be performed, in the air-to-air (A/A) or in the air-to-ground (A/G) roles, it is evident that non specialized aircraft will be used and also low cost aircraft will be chosen more and more often. This analysis is limited to the different aircraft which were or are still in use in European airforces or more generally in the European theater of operations. This theater is very demanding due to different factors such as the threat and the weather. The concept of multi-role aircraft, being considered as the ideal choice by many, is discussed as a response to the variety of requirements in the European theater. Another point that is discussed is pilot training in peace time. The use of simulators is mentioned to show how it is possible to maintain a high level of proficiency for the pilots. Author

N87-24454# Air Force Systems Command, Andrews AFB, Md. Test and Evaluation.
THE INTEGRATION AND OPERATIONAL SUITABILITY OF EMERGING TECHNOLOGIES FOR FUTURE FIGHTER AIRCRAFT: A PILOT'S PERSPECTIVE
John M. Hoffman *In* AGARD Integrated Design of Advanced Fighters May 1987 9 p (For primary document see N87-24445 18-05)
Copyright Avail: NTIS HC A10/MF A01

The tactical air mission has become extremely challenging and complex due to improvements in ground defenses and sophistication of opposing threat air forces. To fight, survive, and win in this demanding environment, the capabilities must be developed which are needed by the tactical pilots to successfully counter the threat. Technological developments have fostered a host of new capabilities for application to future aircraft. A pilot's perspective on the development, integration, and application of these emerging technologies for the air superiority mission is provided. Of real concern is determining which capabilities will be most useful to the pilot, yet not overload or exceed his capacity to perform. Assessments are based on personal experiences in combat, in flight testing applications in current fighter aircraft, and

on plans for incorporation in future fighter aircraft. The pilot/vehicle interface and enhanced pilot performance is the central focus, conditioned by operational suitability. Key factors include information or task saturation, situational awareness, physiological limitations, and cockpit designs. The concept of Fighter Battle Management is introduced. Author

N87-24455*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SYMBOLIC GENERATION OF ELASTIC ROTOR BLADE EQUATIONS USING A FORTRAN PROCESSOR AND NUMERICAL STUDY ON DYNAMIC INFLOW EFFECTS ON THE STABILITY OF HELICOPTER ROTORS

T. S. R. Reddy Jun. 1986 113 p

(NASA-TM-86750; A-85227; NAS 1.15:86750) Avail: NTIS HC A06/MF A01 CSCL 01C

The process of performing an automated stability analysis for an elastic-bladed helicopter rotor is discussed. A symbolic manipulation program, written in FORTRAN, is used to aid in the derivation of the governing equations of motion for the rotor. The blades undergo coupled bending and torsional deformations. Two-dimensional quasi-steady aerodynamics below stall are used. Although reversed flow effects are neglected, unsteady effects, modeled as dynamic inflow are included. Using a Lagrangian approach, the governing equations are derived in generalized coordinates using the symbolic program. The program generates the steady and perturbed equations and writes into subroutines to be called by numerical routines. The symbolic program can operate on both expressions and matrices. For the case of hovering flight, the blade and dynamic inflow equations are converted to equations in a multiblade coordinate system by rearranging the coefficients of the equations. For the case of forward flight, the multiblade equations are obtained through the symbolic program. The final multiblade equations are capable of accommodating any number of elastic blade modes. The computer implementation of this procedure consists of three stages: (1) the symbolic derivation of equations; (2) the coding of the equations into subroutines; and (3) the numerical study after identifying mass, damping, and stiffness coefficients. Damping results are presented in hover and in forward flight with and without dynamic inflow effects for various rotor blade models, including rigid blade lag-flap, elastic flap-lag, flap-lag-torsion, and quasi-static torsion. Results from dynamic inflow effects which are obtained from a lift deficiency function for a quasi-static inflow model in hover are also presented. Author

N87-24456 British Aerospace Public Ltd. Co., Weybridge (England). Aerodynamics Dept.

QUIET AIRCRAFT STUDY. AERODYNAMIC CONSIDERATIONS OF PROPOSED SWEPT SHIELDED AIRCRAFT CONFIGURATIONS

Jul. 1982 38 p

(BAe-Aero/Proj/087; BR72788; ETN-87-99824) Avail: Issuing Activity

It is shown that there may be handling problems associated with the change of trim with power and that the increased trimming losses have significant performance penalties at the larger take-off flap angles of swept shielded aircraft. While it does not appear that the proximity of the nacelles to the wing results in any intake design problems, the induced effects of the nacelles on the wing must be allowed for in the wing design. Further work is required to evaluate the implications on wing root design. A specification for a low speed wind tunnel model to investigate the induced power effects on the tail surfaces is given. ESA

N87-24457*# Sikorsky Aircraft, Stratford, Conn.

A ROTORCRAFT FLIGHT/PROPULSION CONTROL INTEGRATION STUDY Report, Jun. 1984 - Jun. 1986

D. G. C. Ruttledge Nov. 1986 211 p

(Contract NAS3-24343)

(NASA-CR-179574; NAS 1.26:179574; SER-760606) Avail: NTIS HC A10/MF A01 CSCL 01C

An eclectic approach was taken to a study of the integration of digital flight and propulsion controls for helicopters. The basis of the evaluation was the current Gen Hel simulation of the UH-60A Black Hawk helicopter with a model of the GE T700 engine. A list of flight maneuver segments to be used in evaluating the effectiveness of such an integrated control system was composed, based on past experience and an extensive survey of the U.S. Army Air-to-Air Combat Test data. A number of possible features of an integrated system were examined and screened. Those that survived the screening were combined into a design that replaced the T700 fuel control and part of the control system in the UH-60A Gen Hel simulation. This design included portions of an existing pragmatic adaptive fuel control designed by the Chandler-Evans Company and an linear quadratic regulator (LQR) based N(p) governor designed by the GE company, combined with changes in the basic Sikorsky Aircraft designed control system. The integrated system exhibited improved total performance in many areas of the flight envelope. Author

N87-24458*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

MEASUREMENTS OF FLOW RATE AND TRAJECTORY OF AIRCRAFT TIRE-GENERATED WATER SPRAY

Robert H. Daugherty and Sandy M. Stubbs Jul. 1987 118 p

(NASA-TP-2718; L-16195; NAS 1.60:2718) Avail: NTIS HC A06/MF A01 CSCL 01C

An experimental investigation was conducted at the NASA Langley Research Center to measure the flow rate and trajectory of water spray generated by an aircraft tire operating on a flooded runway. Tests were conducted in the Hydrodynamics Research Facility and made use of a partial airframe and a nose tire from a general aviation aircraft. Nose tires from a commercial transport aircraft were also used. The effects of forward speed, tire load, and water depth on water spray patterns were evaluated by measuring the amount and location of water captured by an array of tubes mounted behind the test tire. Water ejected from the side of the tire footprint had the most significant potential for ingestion into engine inlets. A lateral wake created on the water surface by the rolling tire can dominate the shape of the spray pattern as the distance aft of the tire is increased. Forward speed increased flow rates and moved the spray pattern inboard. Increased tire load caused the spray to become less dense. Near the tire, increased water depths caused flow rates to increase. Tests using a fuselage and partial wing along with the nose gear showed that for certain configurations, wing aerodynamics can cause a concentration of spray above the wing. Author

N87-24459*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

STATIC CALIBRATION OF THE RSRA ACTIVE-ISOLATOR ROTOR BALANCE SYSTEM Final Report

C. W. Acree, Jr. Mar. 1987 40 p

(NASA-TM-88211; A-86115; NAS 1.15:88211) Avail: NTIS HC A01/MF A01 CSCL 01C

The Rotor Systems Research Aircraft (RSRA) active-isolator system is designed to reduce rotor vibrations transmitted to the airframe and to simultaneously measure all six forces and moments generated by the rotor. These loads are measured by using a combination of load cells, strain gages, and hydropneumatic active isolators with built-in pressure gages. The first static calibration of the complete active-isolator rotor balance system was performed in 1983 to verify its load-measurement capabilities. Analysis of the data included the use of multiple linear regressions to determine calibration matrices for different data sets and a hysteresis-removal algorithm to estimate in-flight measurement errors. Results showed that the active-isolator system can fulfill most performance predictions. The results also suggested several possible improvements to the system. Author

N87-24460*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

HELICOPTER HAVING A DISENGAGEABLE TAIL ROTOR Patent Application

Henry L. Kelley, inventor (to NASA) and John C. Wilson, inventor (to NASA) 23 Apr. 1987 14 p

(NASA-Case-LAR-13609-1; NAS 1.71:LAR-13609-1; US-Patent-Appl-SN-041387) Avail: NTIS HC A02/MF A01 CSCL 01C

A helicopter is provided with a tail rotor which can be braked within a predetermined range of speeds, and stopped and locked at a predetermined speed. The helicopter includes a tail portion having a vertical fin extending therefrom. The vertical fin has a rudder movably attached thereto and the tail rotor is rotatably attached to one side of the vertical fin. The braking and stopping of the tail rotor can be performed automatically or manually from the cockpit. A brake and clutch system is provided in a main portion of the helicopter and controls the tail rotor. The rudder becomes operative when the tail rotor is slowed, stopped and locked so as to provide fine control of the helicopter especially at high speeds. Thus, the helicopter can fly at higher speeds without incurring aerodynamic loads thereon which occur at high speeds. In addition to the reduced noise from the helicopter with the tail rotor stopped, the safety of the helicopter, especially when boarding and deplaning passengers during emergency situations, is increased. NASA

N87-24461*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IMPROVED CONTROL SURFACE ACTUATOR Patent Application
Gerhard E. Seidel, inventor (to NASA) (Boeing Co., Renton, Wash.) 23 Mar. 1987 10 p
(NASA-Case-LAR-12852-1; NAS 1.71:12852-1; US-Patent-Appl-SN-028832) Avail: NTIS HC A02/MF A01 CSCL 01C

A device which actuates aircraft control surfaces is disclosed. The actuator is disposed entirely within the control surface structure. This allows the gap between the wing structural box and the control surface to be reduced. Reducing the size of the gap is especially desirable for wings with high aspect ratio, wherein the volume of the structural box is at a premium. NASA

N87-24411*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
V/STOL AND STOL GROUND EFFECTS AND TESTING TECHNIQUES
R. E. Kuhn *In its* Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 1-145 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01C

N87-24421*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE GROUND EFFECTS OF A POWERED-LIFT STOL AIRCRAFT DURING LANDING APPROACH
Victor C. Stevens *In its* Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 395-413 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01C

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

N87-24462# European Space Agency, Paris (France).
LABORATORY TESTS OF THE SENSORS OF THE STEINHEIL-LEAR SIEGLER STRAPDOWN MEASUREMENT UNIT MODEL 1903-SB FOR MODEL ATTITUDE MEASUREMENTS IN A WIND TUNNEL. VOLUME 2 OF THE DOCUMENTATION ON THE MODEL ATTITUDE MEASUREMENT SYSTEM (MAMS) FOR THE GERMAN/DUTCH WIND TUNNEL (DNW)
Volker Wetzig and Egmar Luebeck Dec. 1986 70 p Transl. into ENGLISH of "Labortests der Sensoren des Strapdown-Systems Model 1903-SB der Firma Steinheil-Lear-Siegler zur Lagemessung von Modellen im Windkanal" DFVLR, Brunswick (West Germany), Apr. 1986 Original language document was previously announced as N87-14682
(ESA-TT-1017-Vol-2; DFVLR-Mitt-86-15-Vol-2; ETN-87-99854)
Avail: NTIS HC A04/MF A01; orginal German version available from DFVLR, Cologne, West Germany DM 26

Laboratory tests of the sensors for the Model Attitude Measurement System (MAMS) were performed. The sensor units, the test equipment, and the data acquisition are discussed. The sensor tests included rate tests for the investigation of the gyroscope scale factors and measuring axis misalignments, multiposition tests to determine constant and g-dependent gyroscope drift and to calibrate accelerometers, as well as stability tests to evaluate gyroscope drift variations. The results are given in tables with coefficients for error compensation, and with indications concerning short and longterm variations of the coefficients and measured values. ESA

N87-24949# Naval Air Development Center, Warminster, Pa.
NEW TECHNOLOGY IMPACTS ON FUTURE AVIONICS ARCHITECTURES
Richard S. Mejzak *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 7 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N87-24463# Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.
APPLICATION OF SYSTEM IDENTIFICATION TECHNIQUES TO COMBUSTOR POSTSTALL DYNAMICS Final Report, Dec. 1984 - Sep. 1986
L. L. Steele, J. R. Grant, Jr., D. P. Harrold, and J. J. Erhart Feb. 1987 142 p
(Contract F33615-84-C-2432)
(AD-A178082; P/W/GPD-FR-18829; AFWAL-TR-86-2105) Avail: NTIS HC A07/MF A01 CSCL 21E

The combustor (main-burner) of gas turbine engines has been identified as a significant contributor to the degree of recoverability of engine surge events. Whether or not the combustor blows out and if so, whether it rapidly relights, can determine whether or not rotating (nonrecoverable) stall will occur. Component stall investigations have traditionally concentrated on the compression system and experience has shown that traditional methods of obtaining data are generally inadequate in identifying poststall characteristics. The present program seeks to apply system identification techniques to design experiments which will be suitable for extracting combustor poststall characteristics. Many models, modeling approaches, and combustion physics were examined with objective of providing an improved combustor dynamic model. The one derived under the A.F. Nonrecoverable Stall Investigation (F33615-79-C-2087) was selected as a starting point. Physics improvements were incorporated, including characteristic time approaches for ignition and stability. The planned United Technologies Research Center Transient Combustion Facility was selected as the only cost-effective, flexible test vehicle of all candidates screened. The system identification expertise of Systems Control Technology was used to perform most of the analysis. GRA

N87-24464# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
ENGINE RESPONSE TO DISTORTED INFLOW CONDITIONS
Mar. 1987 304 p In ENGLISH and FRENCH Meeting held in Munich, West Germany, 8-9 Sep. 1986
(AGARD-CP-400; ISBN-92-835-0412-7) Copyright Avail: NTIS HC A14/MF A01

The papers presented at the Propulsion and Energetics Panel 68th Specialists' Meeting are compiled. Individual sessions covered the following subjects: unsteady flow and validation of empirical distortion parameters; computation techniques for engine/compressor performance predictions of distorted inflow; distorted inflow detection; and experimental investigations of engine instability and response to flow distortion. A technical evaluation report summarizing the conference is also presented. For individual titles, see N87-24465 through N87-24480.

N87-24465# Rolls-Royce Ltd., Bristol (England). Dept. of Installation Technology.
REVIEW OF CURRENT KNOWLEDGE ON ENGINE RESPONSE TO DISTORTED INFLOW CONDITIONS
D. D. Williams *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 32 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

An overview to the 68th Propulsion and Energetics Panel (PEP) Specialists Meeting is presented. Some current aspects of time-variant, spatial total-pressure distortion and other forms such as swirl, static-pressure distortion, planar-wave perturbations of total pressure, and total temperature distortion are reviewed. Engine response considerations include the influence of engine spool coupling on stability, developments in the modeling of total-pressure circumferential extent effects, and swirl/total-pressure interactions. Guidelines for the formulation of distortion descriptors and performance/stability assessments are reviewed. Author

N87-24466# Societe Nationale d'Etudes et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France).
AIR INLET/ENGINE COMPATIBILITY: IMPACT OF THEORETICAL AND EXPERIMENTAL METHODS [COMPATIBILITE ENTREE D'AIR-MOTEUR IMPACT DES METHODES THEORIQUES ET EXPERIMENTALES]
Marius Goutines and Hugues Joubert *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 20 p In FRENCH (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

Work carried out at SNECMA (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation) to develop clean-flow surge line predictions and numerical distortion-response codes is reported. The experimental efforts defined a state-of-the-art, time-invariant total pressure data acquisition system and a simple means of generating and simulating dynamic pressure distortion. Parametric studies indicate that compressor inlet guide vanes, low-aspect-ratio blades, and small blade row gaps increase stall margin and reduce compressor distortion sensitivities. M.G.

N87-24467# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Group.
NEW TRENDS IN INTAKE/ENGINE COMPATIBILITY ASSESSMENT
F. Aulehla and D. M. Schmitz *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 24 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

The measurement of dynamic distortion requires considerable effort in instrumentation and data processing. Distortion measurement methods which are time and cost efficient are described. Experience gained from the Tornado aircraft indicates that the relevance of dynamic distortion on intake/engine compatibility has been overestimated and, in fact, swirl emerged as the decisive compatibility parameter. Also, during the Airbus A-300 APU intake development swirl turned out to be an important criterion. In conclusion, it is argued whether in many cases dynamic distortion measurements can be avoided in favor of swirl measurements in combination with simplified methods for dynamic distortion predictions based on steady state measurements and, in some cases, on statistical models. Author

N87-24468# Technische Hochschule, Aachen (West Germany). Inst. for Jet Propulsion and Turbomachinery.
EFFECT OF STEADY STATE INLET TEMPERATURE DISTORTION ON THE ENGINE COMPRESSOR FLOW
W. Koschel, H. Kuenkler, and H. Toenskoetter (Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, West Germany) *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 19 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

A prediction model for the effects of a steady state temperature distortion on the overall performance of a multistage engine compressor is presented. In contrast to the well known parallel compressor model this model takes into account the circumferential interaction of the distorted and undistorted compressor flow. An extensive experimental program was carried out on a single-spool jet engine with steady-state inlet temperature and pressure distortion tests. The experimental set-up is briefly described. Detailed results of the flow measurements obtained at the compressor inlet and exit and at the compressor interstage positions are presented and discussed. The experimental results support the validity of the prediction model developed as part of this project. Author

N87-24469*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VISCOUS ANALYSES FOR FLOW THROUGH SUBSONIC AND SUPERSONIC INTAKES
Louis A. Povinelli and Charles E. Towne *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 20 p (For primary document see N87-24464 18-07)
Copyright Avail: NTIS HC A14/MF A01

A parabolized Navier-Stokes code was used to analyze a number of diffusers typical of a modern inlet design. The effect of curvature of the diffuser centerline and transitioning cross sections was evaluated to determine the primary cause of the flow distortion in the duct. Results are presented for S-shaped intakes with circular and transitioning cross sections. Special emphasis is placed on verification of the analysis to accurately predict distorted flow fields resulting from pressure-driven secondary flows. The effect of vortex generators on reducing the distortion of intakes is presented. Comparisons of the experimental and analytical total pressure contours at the exit of the intake exhibit good agreement. In the case of supersonic inlets, computations of the inlet flow field reveal that large secondary flow regions may be generated just inside of the intake. These strong flows may lead to separated flow regions and cause pronounced distortions upstream of the compressor. Author

N87-24470*# Cambridge Univ. (England).
CALCULATIONS OF INLET DISTORTION INDUCED COMPRESSOR FLOWFIELD INSTABILITY
T. P. Hynes, R. Chue, E. M. Greitzer, and C. S. Tan (Massachusetts Inst. of Tech., Cambridge.) *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 16 p (For primary document see N87-24464 18-07)
(Grant NsG-3208)
Copyright Avail: NTIS HC A14/MF A01

Calculations are presented predicting the onset of flow instability for a multistage low speed axial compressor operating in circumferentially distorted inlet flow. The most important feature of the model used is that it attempts to properly account for the fluid dynamic interaction between the spoiled and unspoiled sectors of the compressor. The calculations show that there is an approximate stability criterion, the annulus averaged slope of the compressor pressure rise characteristic equal to zero, that is valid whenever the dynamics of the compressor distorted flowfield can

be considered independent of the compressor environment. This appoximate criterion is used to investigate the relationship between the present model and the parallel compressor model. Further calculations are performed to investigate cases of interest when the dynamics of the flowfield are coupled to the environment. Resonant cases and cases when the distortion is unsteady are studied. In particular, it is shown that rotating distortions which propagate in the rotor direction can have a greater effect on stability margin than stationary or counter-rotational ones. Finally, it is shown that the general predictions of the model are insensitive to the details of the unsteady bladerow dynamics. Author

N87-24471# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
NUMERICAL STUDY OF THE PROPAGATION OF AN INLET FLOW DISTORTION THROUGH AN AXIAL COMPRESSOR
Germain Billet, Philippe Chevalier, and Pierre Laval *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 14 p In FRENCH; ENGLISH summary Sponsored by DRET (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

A model representing the response of fixed or rotating axial compressor blade rows is coupled to a 3-D numerical simulation of the flow outside the blade rows. The code can be used to study nonuniform compressible 3-D flows through turbomachines. The fluid is assumed to be inviscid in the space outside the rows, while viscous effects are taken into account inside. Numerical results are compared with experimental data in the case of a low speed single stage compressor with an inlet steady total pressure distortion. These comparisons show that the numerical approach is able to predict the global response of the compressor. This work is part of a larger project aimed at predicting the response of a compressor to a nonuniform inlet flow that is periodic in time, or fully unsteady. Author

N87-24472# Societe Bertin et Cie, Plaisir (France).
CALCULATION OF CASCADE FLOW BEHAVIOR IN A DYNAMIC STALL REGIME [CALCUL DU DPMIPRTE,EMT D'UNE GRILLE D'AUBES EN REGIME DE DECROCHAGE DYNAMIQUE]
P. Gillant, P. Sagnes, and JP. Ollier *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 20 p In FRENCH (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

An overview is presented of a singularity method coupled with an unsteady boundary layer calculation for modeling unsteady subsonic cascade flow in unstalled and dynamic stall regimes. The short term aim of the work is to provide a method for assessing the distortion sensitivity of multistage axial compressors. Good numerical results have been obtained for steady flow and unsteady attached flow but quantitative validation is difficult due to the paucity of relevant experimental data. For dynamic stall, the studies show the importance of correct modelling of the flow in the neighborhood of the separation point. M.G.

N87-24473# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Inst. fuer Antriebstechnik.
IMPROVEMENT OF THE PARALLEL COMPRESSOR MODEL BY CONSIDERATION OF UNSTEADY BLADE AERODYNAMICS
M. Lecht *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 13 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

The parallel compressor model has been applied to predict compressor performance with cicumferential total inlet distortion. In comparison with experiment data, however, this model gives pessimistic results for the predicted stall line shift considering sector angles of distortion up to 120 deg. Detailed experimental evaluation of a compressor stage leads to unsteady performance effects obviously being responsible for this discrepancy. In order to improve the original model the performance characteristic of the compressor was extended to account for a short time overload capability analogous to an airfoil in an unsteady flow. The governing factor of this modification is the time-to-stall versus the time for a blade channel to pass the distorted sector. The model improvement was demonstrated for a DFVLR and a NASA single stage transonic compressor subjected to a screen induced total pressure distortion. Author

N87-24474# General Electric Co., Evendale, Ohio. Aircraft Engine Business Group.
TURBOFAN ENGINE POST-INSTABILITY BEHAVIOR: COMPUTER SIMULATIONS, TEST VALIDATION AND APPLICATION OF SIMULATIONS
William G. Steenken *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 11 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

A method that can be used to predict the post-stability operation of a turbofan engine and is based upon extending the capabilities of engine transient cycle decks is described. Typical predictions are presented and compared with results obtained from the testing of a modern augmented turbofan engine. The potential manners in which this digital computer simulation tool may be utilized are also discussed. Author

N87-24475# Royal Aircraft Establishment, Farnborough (England).
TRANSMISSION OF INLET DISTORTION THROUGH A FAN
J. E. Flitcroft, J. Dunham, and W. A. Abbott *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 11 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

The effect of inlet swirl on the propagation of total pressure distortion through a three-stage fan without inlet guide vanes was investigated on a compressor rig. The tests gave the unexpected finding that the presence of a swirl counter to the rotation of the fan generally reduced the level of steady state distortion transmitted to the core compressor. Dynamic pressure measurements made at the exit from the fan, however, revealed that the swirl also caused a sudden early breakdown of the flow in a sector of the hub region, resulting in high time-invariant distortion levels in the core flow. This observation is compatible with the destabilizing effect of a swirl counter to fan rotation on engines. A theoretical analysis confirmed that a swirl, concentrated at the fan tip at entry, could drive some of the hub blade rows strongly towards stall. Author

N87-24476# Alfa Romeo S.p.A., Naples (Italy). Direzione R and D.
EXPERIMENTAL INVESTIGATION ON SMALL TURBOPROP BEHAVIOUR UNDER COMPRESSOR ROTATING STALL FOR DIFFERENT INLET FLOW CONDITIONS
S. Colantuoni and G. Liotti *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 16 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

An experimental investigation on compressor rotating stall and acoustic noise in a small turboprop is discussed. The intent of the study, undertaken in Alfa Romeo Avio using the engine test bed during the initial phase of the AR 318 turboprop development program, was to clarify the noisy and unstable behavior of some engines at part-speeds. The overall performances of the centrifugal compressor, the time-dependent wall static pressure measurements used to visualize impeller rotating stall regions on the compressor map, and the acoustic noise signals detected at the engine-intake inlet are presented. Finally, the engine performances in stalled compressor conditions are analyzed and main results are discussed. Author

N87-24477*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUMMARY OF INVESTIGATIONS OF ENGINE RESPONSE TO DISTORTED INLET CONDITIONS
Thomas J. Biesiadny, Willis M. Braithwaite, Ronald H. Soeder, and Mahmood Abdelwahab *In* AGARD Engine Response to

Distorted Inflow Conditions Mar. 1987 21 p Previously announced as N86-26336 (For primary document see N87-24464 18-07)
Copyright Avail: NTIS HC A14/MF A01

A survey is presented of experimental and analytical experience of the NASA Lewis Research Center in engine response to inlet temperature and pressure distortions. Results of experimental investigations and analytical modeling are reviewed together with a description of the hardware and the techniques employed. Distortion devices successfully simulated inlet distortion, and knowledge was gained on compression system response to different types of distortion. A list of NASA research references is included. Author

N87-24478# Rockwell International Corp., Los Angeles, Calif. Aircraft Operations.
UNSTEADY INLET DISTORTION CHARACTERISTICS WITH THE B-1B c02
C. J. MacMiller and W. R. Haagenson *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 17 p (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

An extensive wind tunnel and flight test program was conducted to verify inlet performance and distortion characteristics on the B-1B aircraft. During the course of these investigations, several unsteady, total-pressure disturbances at various discrete frequencies were encountered: (1) inlet duct resonance at low power settings; (2) environmental control system (ECS) precooler duct resonance; and (3) nose gear wake ingestion. This resulted in the need to quantify these effects and assess the impact on engine stability characteristics. As a result, engine control features were modified, and aircraft configuration changes were implemented. Results and findings of these investigations are summarized. Author

N87-24479# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
EXPERIMENTAL DETERMINATION OF THE TRANSFER FUNCTION OF AN AXIAL COMPRESSOR TO DISTORTED INLET FLOW [DETERMINATION EXPERIMENTALE DES LOIS DE TRANSFERT DE PERTURBATIONS A LA TRAVERSEE D'UN COMPRESSEUR AXIAL] c02
Jacques Huard *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 11 p In FRENCH; ENGLISH summary Original language document was announced in IAA as A87-21025 (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

Transfer equations were identified for disturbances introduced into an axial flow compressor by disturbances to the flow across the inlet. The rotating blade rows are represented as a semi-actuator disk and aerothermodynamic values of the flow upstream and downstream of the disk are related by the transfer equations. The equations were derived from experimental data on the displacement of streamlines and the pressure changes after a distortion screen upstream from a blade row. Upstream flow distortions had a linear quasi-sinusoidal periodicity, while those between rows varied bilinearly. IAA

N87-24480# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Div.
DEVELOPMENT OF INTAKE SWIRL GENERATORS FOR TURBO JET ENGINE TESTING c09
H. P. Genssler, W. Meyer, and L. Fottner (Technische Univ., Munich, West Germany) *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 21 p Sponsored in part by the German Bundesministerium der Verteidigung (For primary document see N87-24464 18-07)
Avail: NTIS HC A14/MF A01

The main objective of this investigation is to assess the influence of different types and magnitudes of swirl on the performance and compatibility of turbojet engines. The generation of intake swirl, typical for many supersonic combat aircraft, is described. Essentially two basic types, i.e., twin swirl and bulk swirl of varying strength and also combinations thereof, were selected in order to simulate these swirl patterns by subscale generators in a model wind tunnel. The swirl patterns measured behind these generators show good agreement with the target patterns selected at the beginning. The small scale swirl generators are being rebuilt at full scale for subsequent testing in front of the Larzac engine under static conditions with a bellmouth inlet at the engine test facility of the Jet Propulsion Institute at the Universitaet der Bundeswehr Muenchen. Author

N87-24481*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LOW-COST FM OSCILLATOR FOR CAPACITANCE TYPE OF BLADE TIP CLEARANCE MEASUREMENT SYSTEM
John P. Barranger Jul. 1987 16 p
(NASA-TP-2746; E-3455; NAS 1.60:2746) Avail: NTIS HC A02/MF A01 CSCL 21E

The frequency-modulated (FM) oscillator described is part of a blade tip clearance measurement system that meets the needs of a wide class of fans, compressors, and turbines. As a result of advancements in the technology of ultra-high-frequency operational amplifiers, the FM oscillator requires only a single low-cost integrated circuit. Its carrier frequency is 42.8 MHz when it is used with an integrated probe and connecting cable assembly consisting of a 0.81 cm diameter engine-mounted capacitance probe and a 61 cm long hermetically sealed coaxial cable. A complete circuit analysis is given, including amplifier negative resistance characteristics. An error analysis of environmentally induced effects is also derived, and an error-correcting technique is proposed. The oscillator can be calibrated in the static mode and has a negative peak frequency deviation of 400 kHz for a rotor blade thickness of 1.2 mm. High-temperature performance tests of the probe and 13 cm of the adjacent cable show good accuracy up to 600 C, the maximum permissible seal temperature. The major source of error is the residual FM oscillator noise, which produces a clearance error of + or - 10 microns at a clearance of 0.5 mm. The oscillator electronics accommodates the high rotor speeds associated with small engines, the signals from which may have frequency components as high as 1 MHz. Author

N87-24418*# Rolls-Royce Ltd., Bristol (England). Military Installation.
THE SCALING OF MODEL TEST RESULTS TO PREDICT INTAKE HOT GAS REINGESTION FOR STOVL AIRCRAFT WITH AUGMENTED VECTORED THRUST ENGINES
C. J. Penrose *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 309-339 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 01A

N87-24419*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HOT GAS INGESTION: FROM MODEL RESULTS TO FULL SCALE ENGINE TESTING
Albert L. Johns, Thomas J. Biesiadny, and L. L. Pagel (McDonnell Aircraft Co., St. Louis, Mo.) *In* NASA. Ames Research Center Proceedings of the 1985 NASA Ames Research Center's Ground-Effects Workshop Feb. 1987 p 341-361 (For primary document see N87-24410 18-02)
Avail: NTIS HC A19/MF A01 CSCL 21E

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N87-24482*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

INFLUENCE OF DYNAMIC INFLOW ON THE HELICOPTER VERTICAL RESPONSE

Robert T. N. Chen and William S. Hindson (Stanford Univ., Calif.) Jun. 1986 49 p

(NASA-TM-88327; A-86262; NAS 1.15:88327) Avail: NTIS HC A03/MF A01 CSCL 01C

A study was conducted to investigate the effects of dynamic inflow on rotor-blade flapping and vertical motion of the helicopter in hover. Linearized versions of two dynamic inflow models, one developed by Carpenter and Fridovich and the other by Pitt and Peters, were incorporated in simplified rotor-body models and were compared for variations in thrust coefficient and the blade Lock number. In addition, a comparison was made between the results of the linear analysis, and the transient and frequency responses measured in flight on the CH-47B variable-stability helicopter. Results indicate that the correlations are good, considering the simplified model used. The linear analysis also shows that dynamic inflow plays a key role in destabilizing the flapping mode. The destabilized flapping mode, along with the inflow mode that the dynamic inflow introduces, results in a large initial overshoot in the vertical acceleration response to an abrupt input in the collective pitch. This overshoot becomes more pronounced as either the thrust coefficient or the blade Lock number is reduced. Compared with Carpenter's inflow model, Pitt's model tends to produce more oscillatory responses because of the less stable flapping mode predicted by it. Author

N87-24483*# Dayton Univ., Ohio.

IMPROVEMENTS TO THE FASTEX FLUTTER ANALYSIS COMPUTER CODE Final Report

Ronald F. Taylor Jul. 1987 80 p

(Grant NAG2-377)

(NASA-CR-181072; NAS 1.26:181072; UDR-TR-87-14) Avail: NTIS HC A05/MF A01 CSCL 01C

Modifications to the FASTEX flutter analysis computer code (UDFASTEX) are described. The objectives were to increase the problem size capacity of FASTEX, reduce run times by modification of the modal interpolation procedure, and to add new user features. All modifications to the program are operable on the VAX 11/700 series computers under the VAX operating system. Interfaces were provided to aid in the inclusion of alternate aerodynamic and flutter eigenvalue calculations. Plots can be made of the flutter velocity, display and frequency data. A preliminary capability was also developed to plot contours of unsteady pressure amplitude and phase. The relevant equations of motion, modal interpolation procedures, and control system considerations are described and software developments are summarized. Additional information documenting input instructions, procedures, and details of the plate spline algorithm is found in the appendices. M.G.

N87-24404 Stevens Inst. of Tech., Hoboken, N. J. Dept. of Mechanical Engineering.

STALL FLUTTER

F. Sisto *In* AGARD Aeroelasticity in Axial-Flow Turbomachines. Volume 1: Unsteady Turbomachinery Aerodynamics Mar. 1987 11 p (For primary document see N87-24398 18-02)

Copyright Avail: NTIS HC A13/MF A01

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N87-24484*# Eastman Kodak Co., Rochester, N. Y. Government Systems Div.

NASA STAR SIMULATOR Final Report

1 Oct. 1986 29 p

(Contract NAS8-36761)

(NASA-CR-179130; NAS 1.26:179130) Avail: NTIS HC A03/MF A01 CSCL 14B

A star simulator is described which is capable of simulating a field of three or more stars in response to signals from a computer interface. Star magnitude and spectral output can be manipulated and absolute position measurements can be obtained with the system. The simulator is a single axis system which consists of two assemblies: a light source and filter wheel assembly, and a translation stage assembly. The assemblies are self contained on 60.96 x 60.96 cm breadboards and are connected via three fiber optic cables. A summary of operational modes is provided. M.G.

N87-24485*# National Aeronautics and Space Administration, Washington, D.C.

TEST OF A TRAIL CRYOGENIC BALANCE IN THE ONERA T2 WIND TUNNEL

A. Blanchard, A. Seraudie, M. Plazanet, and M. J. Payry Jul. 1987 106 p Transl. into ENGLISH of "Essai de la Balance Probatoire Cyrogenique ONERA dans la Soufflerie T2" rept. DERAT-TR-22/5007-DN France, Jul. 1985 47 p Transl. by Kanner (Leo) Associates, Redwood City, Calif.

(Contract NASw-4005)

(NASA-TT-20078; NAS 1.77:20078; DERAT-TR-22/5007-DN) Avail: NTIS HC A06/MF A01 CSCL 14B

The three component cryogenic balance designed and manufactured by the ONERA Large Means Directorate, was equipped with a light alloy schematic model and tested at the end of 1984 at the T2 wind tunnel in gusts at low temperatures up to 120 K. The tests pertained to the impact of the cryogenic conditions on the behavior of extensometric bridges while cooling the balance-model system mounted in the conditioning device and during gusts with models in the test section. A few tests with thermal disequilibrium between the flow and balance made it possible to confirm the proper operation in the range 120 to 300 K. This gust system showed that the balance, which was well compensated thermally, may be used in T2 with and without precooling. For any thermal gradient, the analysis was always performed with the same matrices and aerodynamic coefficients were obtained with the same precision. Author

N87-24480# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Div.

DEVELOPMENT OF INTAKE SWIRL GENERATORS FOR TURBO JET ENGINE TESTING

H. P. Genssler, W. Meyer, and L. Fottner (Technische Univ., Munich, West Germany) *In* AGARD Engine Response to Distorted Inflow Conditions Mar. 1987 21 p Sponsored in part by the German Bundesministerium der Verteidigung (For primary document see N87-24464 18-07)

Avail: NTIS HC A14/MF A01

N87-24946# Rome Air Development Center, Griffiss AFB, N.Y.

ADVANCED SENSOR EXPLOITATION

Joseph Antonik and Leonard E. Converse, Jr. *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 5 p (For primary document see N87-24940 18-66)

Copyright Avail: NTIS HC A07/MF A01

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

N87-24486# Royal Netherlands Aircraft Factories Fokker, Amsterdam. Attitude Control Dept.
END EFFECTOR DEVELOPMENT STUDY. VOLUME 2: SERVICE END EFFECTOR SUBSYSTEM SPECIFICATION (SEESSPEC) Final Report
Aad vanSwieten Paris, France ESA 15 Jul. 1986 42 p
(Contract ESA-1682/84-NL-AN)
(FOK-TR-R-86-091-Vol-2; ESA-CR(P)-2346-Vol-2; ETN-87-99887)
Avail: NTIS HC A03/MF A01
An update of the service end effector subsystem specification, based on the experiences obtained during the design iteration of the second phase, is presented. ESA

N87-25028# Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics.
PHYSICS IN SPACE: THE EXAMPLE OF THE VEGA MISSION
Karoly Szegoe *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 13-20
(For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25029# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Space Science Dept.
MAIN ACHIEVEMENTS AND FUTURE PLANS IN ESA'S PROGRAM
Arne Pedersen *In its* Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 21-24
(For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25030# National Aeronautics and Space Administration, Washington, D.C.
EXPLORATION OF THE SOLAR SYSTEM: ACHIEVEMENTS AND FUTURE PLANS IN NASA'S PROGRAMME
William E. Brunk *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 25-29
(For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25136# Astronomische Rechen-Institut, Heidelberg (West Germany).
A GROUND-BASED OBSERVING STRATEGY FOR FUTURE COMETARY MISSIONS
S. Roeser *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 217-219
(For primary document see N87-25109 18-90)
Copyright Avail: NTIS HC A11/MF A01

N87-25137# Observatoire du Mont-Gros, Nice (France).
FEASIBILITY OF A MISSION TO COMET P/SCHWASSMANN-WACHMANN 1
D. Benest and J. Klinger (Centre National de la Recherche Scientifique, Saint Martin d'Heres, France) *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 221-224 (For primary document see N87-25109 18-90)
(Grants ATP-5773AP86; ATP-5729)
Copyright Avail: NTIS HC A11/MF A01

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N87-24487# Applications Mathematiques et Logiciel, Neuilly-sur-Seine (France).
TRANSFER TO LIBRATIONS POINT ORBITS
Paris, France ESA 1986 153 p
(Contract ESA-4749/83-D-JS)
(AML-3438-86; ESA-CR(P)-2322; ETN-87-99876) Copyright
Avail: NTIS HC A08/MF A01
To help develop a mission analysis tool for the selection of optimum transfer orbits and launch window calculations, an analytical study of approximate admissible transfer trajectories was done to identify the domains of existence of solutions, and provide initial solutions for an iterative process. A method for solving the general two-point boundary value problem which arises naturally with the determination of an admissible transfer trajectory of fixed duration was developed. To solve the optimization problem itself, with the selection of transfer duration and other free parameters, a fairly general, numerically well-behaved technique as provided by descent method is used. ESA

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

N87-24488# Air Force Occupational and Environmental Health Lab., Brooks AFB, Tex.
SPACE LAUNCH COMPLEX 6 WASTEWATER TREATMENT FACILITIES EVALUATION, VANDENBERG AFB, CALIFORNIA Final Report, 13 May - 1 Jun. 1986
Robert D. Binovi and Francis E. Slavich Feb. 1987 35 p
(AD-A179162; USAFOEHL-87-016EQ0195BSC) Avail: NTIS HC A03/MF A01 CSCL 13B
The USAFOEHL conducted a survey evaluating the wastewater treatment facility at the Space Launch Complex 6 (SLC-6), Vandenberg AFB, California. The scope of the survey included the evaluation of: (1) Plant influent and effluent quality, (2) Plant flows, (3) Lift station sewage quality, (4) Percolation pond water quality, (5) Percolation pond discharge flow rate. Results of the survey showed that the treatment plant was not meeting the State of California zero discharge limitation because of hydraulic overloading. Hydraulic overloading was the probable cause of high suspended solids in the plant effluent. The percolation ponds ability to dispose of the wastewater suffered from this heavy solids loading. The long residence time in the lift station, and the surge of the flow to the plant caused by Lift Station 1 adversely affected the treatment process. GRA

N87-24489# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
ROCKET ALTITUDE TEST FACILITIES REGISTER
P. Ducasse Mar. 1987 84 p
(AGARD-AG-297; AGARDograph-297; ISBN-92-835-0404-6)
Avail: NTIS HC A05/MF A01
In 1982, the Propulsion and Energetics Panel Working Group 17 endeavored to investigate test techniques applied to solid rocket motors with metallized propellants. It was stated that there is a large number of related test facilities in existence with a large variety of technologies applied and test possibilities offered. It was decided to compile a register showing the major altitude test facilities with their characteristic data. Emphasis was put on facilities capable of performing research and development tests. Author

N87-24490# Aeritalia S.p.A., Naples (Italy). Space Systems Group.
ATTITUDE AND ORIENTATION SYSTEM (AOCS) TASKS ON RENDEZVOUS AND DOCKING (RVD) (DOCKING-UNDOCKING PHASES). ARCHITECTURE OF THE WHOLE SIMULATOR, VOLUME 2 Final Report
Paris, France ESA Feb. 1986 270 p
(Contract ESA-4750/81-NL-AK(SC))

(LP-RP-AI-204-Vol-2; ESA-CR(P)-2313-Vol-2; ETN-87-99869)
Avail: NTIS HC A12/MF A01

The architecture of a spacecraft docking simulator is described. The main functions are: geometrical definition of the spacecraft shape and of the interfacing docking mechanism; dynamic definition of the spacecraft in terms of mass, inertia, stiffness, damping, flexible eigenvectors, and eigenvalues; geometrical interference analysis, localization of the impact point, force or impulse exchanged, integration step control (PREP); preparation and manipulation of the input-output information flow between PREP and DCAP-1; motion simulation (DCAP-1); postelaboration of the output of DCAP-1, reconstruction of the whole geometry; and its visualization. ESA

N87-24491# Aeritalia S.p.A., Naples (Italy). Space Systems Group.
ATTITUDE AND ORIENTATION CONTROL SYSTEM (AOCS) TASKS ON RENDEZVOUS AND DOCKING (RVD) (DOCKING-UNDOCKING PHASES). SIMULATION SET-UP AND RESULTS, VOLUME 3 Final Report
Paris, France ESA Feb. 1986 151 p
(Contract ESA-4750/81-NL-AK(SC))
(LP-RP-AI-204-Vol-3; ESA-CR(P)-2313-Vol-3; ETN-87-99870)
Avail: NTIS HC A08/MF A01

Simulations of cone-cone docking between two rigid bodies; cone-cone docking with a flexible target; and probe-cone docking with rigid target and chaser were performed. Results show that a general purpose DCAP-1 integrated software dedicated to docking is unfeasible. The DCAP code has problems in handling system nontopology due to the way it considers hinges. Ways to overcome these problems are suggested. ESA

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

N87-24492# Joint Publications Research Service, Arlington, Va.
EUROPE REPORT: SCIENCE AND TECHNOLOGY
19 Jun. 1986 160 p Transl. into ENGLISH from various European articles
(JPRS-EST-86-009) Avail: NTIS HC A08/MF A01

Topics addressed include: biotechnology; civil aviation; technology transfer; computers; microelectronics; scientific and industrial policy; lasers; and advanced materials. For individual titles, see N87-24493 through N87-24493.

N87-24493# Joint Publications Research Service, Arlington, Va.
ARIANESPACE TOP PERFORMANCE BENEFITS ESA
Reimar Luest *In its* Europe Report: Science and Technology 19 Jun. 1986 p 2-5 Transl. into ENGLISH from Frankfurter Zeitung/Blick Durch die Wirtschaft (Frankfurt/Main, West Germany), 29 Apr. 1986 p 5 (For primary document see N87-24492 18-15)
Avail: NTIS HC A08/MF A01

The economic exploitation of space is growing in importance. The achievements in telecommunication satellites are reviewed. There are also numerous practical applications of earth reconnaissance from space which are also of considerable significance economically. Examples of these are the monitoring of pollution, sea and coastal surveillance, geological reconnaissance, cartography, and weather forecasting. The exploitation of zero gravity could also be of increasing significance in the areas of materials research and process engineering; chemical processes; liquid and gas physics; pharmacology; and biosciences. The role of the Arianespace is discussed in terms of economic and political impact on Europe. B.G.

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

N87-24494*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
CHRONOLOGY OF KSC AND KSC RELATED EVENTS FOR 1986
Ken Nail, Jr. and Elaine Liston Mar. 1987 135 p
(NASA-TM-89282; KHR-11; NAS 1.15:89282) Avail: NTIS HC A07/MF A01 CSCL 22A

Events at the Kennedy Space Center (KSC) are presented in a monthly format for the year 1986. The Space Shuttle Missions 61-C and 51-L, Delta launchings, and Atlas/Centaur launchings are chronicled. B.G.

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

N87-24761# Institut Geographique National, Paris (France).
APPLICATIONS OF LASER AIRBORNE TELEMETRY AT INSTITUT GEOGRAPHIQUE NATIONAL (IGN), FRANCE
R. Brossier *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 193-199 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N87-24495*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NASA/DOD CONTROL/STRUCTURES INTERACTION TECHNOLOGY, 1986
Robert L. Wright, comp. Jun. 1987 314 p Conference held in Norfolk, Va., 18-21 Nov. 1986
(NASA-CP-2447-Pt-2; L-16242-Pt-2; NAS 1.55:2447-Pt-2) Avail: NTIS HC A14/MF A01 CSCL 22B

Papers presented at the CSI Technology Conference are given. The conference was jointly sponsored by the NASA Office of Aeronautics and Space Technology and the Department of Defense. The conference is the beginning of a series of annual conferences whose purpose is to report to industry, academia, and government agencies the current status of Control/Structures Interaction technology. The conference program was divided into five sessions: (1) Future spacecraft requirements; Technology issues and impact; (2) DOD special topics; (3) Large space systems technology; (4) Control of flexible structures, and (5) Selected NASA research in control structures interaction. For individual titles, see N87-24496 through N87-24512.

N87-24496*# National Aeronautics and Space Administration, Washington, D.C.
SPACE STATION: A PROGRAM OVERVIEW
Judith H. Ambrus *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 579-590 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

An overview is presented of the NASA program for the development of the Space Station. A general representation of the initial Space Station complex is shown. The Space Station goals and program objectives are briefly reviewed, as well as the program schedule. An advanced development program and program management approach are also presented. E.R.

N87-24497*# Air Force Weapons Lab., Kirtland AFB, N. Mex.
JOINT OPTICS STRUCTURES EXPERIMENT (JOSE) c74
David Founds *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 591-602 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 20F

The objectives of the JOSE program is to develop, demonstrate, and evaluate active vibration suppression techniques for Directed Energy Weapons (DEW). DEW system performance is highly influenced by the line-of-sight (LOS) stability and in some cases by the wave front quality. The missions envisioned for DEW systems by the Strategic Defense Initiative require LOS stability and wave front quality to be significantly improved over any current demonstrated capability. The Active Control of Space Structures (ACOSS) program led to the development of a number of promising structural control techniques. DEW structures are vastly more complex than any structures controlled to date. They will be subject to disturbances with significantly higher magnitudes and wider bandwidths, while holding higher tolerances on allowable motions and deformations. Meeting the performance requirements of the JOSE program requires upgrading the ACOSS techniques to meet new more stringent requirements, the development of requisite sensors and acturators, improved control processors, highly accurate system identification methods, and the integration of hardware and methodologies into a successful demonstration.
Author

N87-24498*# General Dynamics Corp., Fort Worth, Tex.
LARGE SPACECRAFT POINTING AND SHALE CONTROL
Arthur L. Hale *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 603-635 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The overall objective of this program was the development of control algorithms that allow the concurrent operation of slewing, pointing, vibration, and shape control subsystems. This objective is important for near-term space surveillance missions that require the rapid retargeting and precise pointing of large flexible satellites. The success of these missions requires the design and concurrent operation of the various interacting control subsystems. There were two phases conducted: phase 1 was mathematical model development, and phase 2 was control development. The program is detailed and major conclusions given. Author

N87-24499*# Honeywell Systems and Research Center, Minneapolis, Minn.
ROBUST CONTROL FOR LARGE SPACE ANTENNAS c37
M. F. Barrett *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 637-664 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 13I

A brief description of program objectives and the space based radar application is given. General characteristics of the 100 m diameter reflector spacecraft are described along with the intended mission and associated requirements, and dynamic characteristics relevant to that mission. Preliminary control analyses are carried out for the critical rapid slew and settle maneuver to establish feedback control requirements and fundamental limitations in meeting those requirements with control hardware for a baseline reaction control system (RCS) jet placement assumed for the open loop bang-bang slew limitations. Control moment gyros (CMGs), angular position sensors, and linear translation sensors are placed for feedback control. Control laws are designed for the improved sensor and actuator placement and evaluated for performance and robustness to unstructured model uncertainty. The robustness of the control design is assessed with respect to modal parameter uncertainty. Results of the control designs analyses are summarized, conclusions are drawn, and recommendations made for future studies. Author

N87-24500*# National Aeronautics and Space Administration, Washington, D.C.
LARGE SPACE SYSTEMS TECHNOLOGY AND REQUIREMENTS
James M. Romero *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 665-673 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Only viewgraphs of this presentation are shown. Outlined are NASA's space emphasis, state of technology, space R&D funding trend and civil space technology initiative. Also given are Control/Structures Interaction Technology (CSTI) focus, program focus on driver missions, in-space technology experiments, and in-space R&T approach. E.R.

N87-24501*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DESIGN, CONSTRUCTION, AND UTILIZATION OF A SPACE STATION ASSEMBLED FROM 5-METER ERECTABLE STRUTS
Martin M. Mikulas, Jr. and Harold G. Bush *In its* NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 675-699 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The primary characteristics of the 5-meter erectable truss is presented, which was baselined for the Space Station. The relatively large 5-meter truss dimension was chosen to provide a deep beam for high bending stiffness yet provide convenient mounting locations for space shuttle cargo bay size payloads which are approx. 14.5 ft (4.4 m) in diameter. Truss nodes and quick attachment erectable joints are described which provide for evolutionary three dimensional growth and for simple maintenance and repair. A mobile remote manipulator system is described which is provided to assist in station construction and maintenance. A discussion is also presented of the construction of the Space Station and the associated extravehicular active (EVA) time.
Author

N87-24502*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CONTROLS-STRUCTURES-ELECTROMAGNETICS ON PROGRAM
William L. Grantham, Marion C. Bailey, Wendell K. Belvin, and Jeffrey P. Williams *In its* NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 701-715 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

A technology development program is described involving Controls Structures Electromagnetics Interaction (CSEI) for large space structures. The CSEI program was developed as part of the continuing effort following the successful kinematic deployment and RF tests of the 15 meter Hoop/Column antenna. One lesson learned was the importance of making reflector surface adjustment after fabrication and deployment. Given are program objectives, ground based test configuration, Intelsat adaptive feed, reflector shape prediction model, control experiment concepts, master schedule, and Control Of Flexible Structures-II (COFS-II) baseline configuration. Author

N87-24503*# Martin Marietta Aerospace, Denver, Colo.
BOX TRUSS ANTENNA TECHNOLOGY STATUS
J. V. Coyner and E. E. Bachtell *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology,

1986 Jun. 1987 p 717-736 Previously announced as 87N-16023 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Recent technology development activities for box truss structures and box truss antennas are summarized. Three primary activities are discussed: the development of an integrated analysis system for box truss mesh antennae; dynamic testing to characterize the effect of joint free play on the dynamic behavior of box truss structures; and fabrication of a 4.5 meter diameter offset fed mesh reflector integrated to an all graphite epoxy box truss cube. Author

N87-24504*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HOOP/COLUMN AND TETRAHEDRAL TRUSS ELECTROMAGNETIC TESTS
M. C. Bailey *In its* NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 737-746 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The distortion of antennas was measured with a metric camera system at discrete target locations on the surface. Given are surface distortion for hoop column reflector antennas, for tetrahedral truss reflector antennas, and distortion contours for the tetrahedral truss reflector. Radiation patterns at 2.27-GHz, 4.26-GHz, 7.73-GHz and 11.6-GHz are given for the hoop column antenna. Also given are radiation patterns at 4.26-GHz and 7.73-GHz for the tetrahedral truss antenna. E.R.

N87-24505*# TRW Space Technology Labs., Redondo Beach, Calif.
APPLICATION OF PHYSICAL PARAMETER IDENTIFICAITON TO FINITE-ELEMENT MODELS
Allen J. Bronowicki, Michael S. Lukich, and Steven P. Kuritz *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 747-755 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The time domain parameter identification method described previously is applied to TRW's Large Space Structure Truss Experiment. Only control sensors and actuators are employed in the test procedure. The fit of the linear structural model to the test data is improved by more than an order of magnitude using a physically reasonable parameter set. The electro-magnetic control actuators are found to contribute significant damping due to a combination of eddy current and back electro-motive force (EMF) effects. Uncertainties in both estimated physical parameters and modal behavior variables are given. Author

N87-24506*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COFS 3 MULTIBODY DYNAMICS AND CONTROL TECHNOLOGY
Robert Letchworth, Paul E. McGowan, and Marc J. Gronet (Lockheed Missiles and Space Co., Sunnyvale, Calif.) *In its* NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 757-765 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

One of the results from the model definition study showed that the maximum scale factor for a replica model is .25. This is dictated by the fixed dimensions of the Large Spacecraft Lab. Replica scaling laws were applied to simplified theoretical models of joints and the joint/tube/joint system. The practical interpretation of the results for the specific Space Station configuration under study yielded a number of conclusions which are briefly discussed. Detailed suspension analyses were conducted to evaluate the ability of the suspended scale model to emulate the dynamic behavior of the free-free Space Station. The results indicated only a slight preference for smaller scales. A candidate erectable Space Station joint was fabricated at full scale, 1/4 scale and 1/3 scale in order to assess the comparability of the scaled joints to the full scale behavior. Another important question discussed is how well the inherent damping characteristics of the scaled joints compare to those of the full scale joint. The preliminary definition study yielded three separate scale factor recommendations for the scale model. Author

N87-24507*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CONTROL TECHNOLOGY OVERVIEW IN CSI
J. B. Dahlgren and A. F. Tolivar *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 767-778 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

A brief control technology overview is given in Control Structures Interaction (CSI) by illustrating that many future NASA mission present significant challenges as represented by missions having a significantly increased number of important system states which may require control and by identifying key CSI technology needs. The JPL CSI related technology developments are discussed to illustrate that some of the identified control needs are being pursued. Since experimental confirmation of the assumptions inherent in the CSI technology is critically important to establishing its readiness for space program applications, the areas of ground and flight validation require high priority. Author

N87-24508*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ANTENNA TECHNOLOGY SHUTTLE EXPERIMENT (ATSE) **c32**
R. E. Freeland, E. Mettler, L. J. Miller, Y. Rahmet-Samii, and W. J. Weber, III *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 779-807 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 20N

Numerous space applications of the future will require mesh deployable antennas of 15 m in diameter or greater for frequencies up to 20 GHz. These applications include mobile communications satellites, orbiting very long baseline interferometry (VLBI) astrophysics missions, and Earth remote sensing missions. A Lockheed wrap rip antennas was used as the test article. The experiments covered a broad range of structural, control, and RF discipline objectives, which is fulfilled in total, would greatly reduce the risk of employing these antenna systems in future space applications. It was concluded that a flight experiment of a relatively large mesh deployable reflector is achievable with no major technological or cost drivers. The test articles and the instrumentation are all within the state of the art and in most cases rely on proven flight hardware. Every effort was made to design the experiments for low cost. Author

N87-24509*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
STRUCTURAL CONTROL BY THE USE OF PIEZOELECTRIC ACTIVE MEMBERS
J. L. Fanson and J.-C. Chen *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 809-829 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Large Space Structures (LSS) exhibit characteristics which make the LSS control problem different form other control problems. LSS will most likely exhibit low frequency, densely spaced and lightly damped modes. In theory, the number of these modes is infinite. Because these structures are flexible, Vibration Suppression (VS) is an important aspect of LSS operation. In terms of VS, the control actuators should be as low mass as possible, have infinite bandwidth, and be electrically powered. It is proposed that actuators be built into the structure as dual purpose structural elements. A piezoelectric active member is proposed for the control of LSS. Such a device would consist of a piezoelectric actuator and sensor for measuring strain, and screwjack actuator in series for use in quasi-static shape control. An experiment simulates an active member using piezoelectric ceramic thin sheet material on a thin, uniform cantilever beam. The feasibility of using the piezoelectric materials for VS on LSS was demonstrated. Positive positive

feedback as a VS control strategy was implemented. Multi-mode VS was achieved with dramatic reduction in dynamic response.
E.R.

N87-24510*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
GROUND TEST OF LARGE FLEXIBLE STRUCTURES
Ben K. Wada *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 831-850 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Many future mission models require large space (LSS) which have accurate surfaces and/or the capability of being accurately aligned. If ground test approaches which will provide adequate confidence of the structrual performance to the program managers are not developed, many viable structural concepts may never be utilized. The size and flexibility of many of the structural concepts will preclude the use of the current ground test methods because of the adverse effects of the terrestrial environment. The challenge is to develop new test approaches which will provide confidence in the capability of LSS to meet performance requirements prior to flight. The activities on ground testing of LSS are described. Since some of the proposed structural systems cannot be tested in entirety, a coordinated ground test analytical model program is required to predict structural performance in space. Several concepts of ground testing under development are addressed.
Author

N87-24511*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SLEW MANEUVERS ON THE SCOLE LABORATORY FACILITY
Jeffrey P. Williams *In its* NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 851-867 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

The Spacecraft Control Laboratory Experiment (SCOLE) was conceived to provide a physical test bed for the investigation of control techniques for large flexible spacecraft. The control problems studied are slewing maneuvers and pointing operations. The slew is defined as a minimum time maneuver to bring the antenna line-of-sight (LOS) pointing to within an error limit of the pointing target. The second objective is to rotate about the LOS within the 0.02 degree error limit. The SCOLE problem is defined as two design challenges: control laws for a mathematical model of a large antenna attached to the Space Shuttle by a long flexible mast; and a control scheme on a laboratory representation of the structure modelled on the control laws. Control sensors and actuators are typical of those which the control designer would have to deal with on an actual spacecraft. Computational facilities consist of microcomputer based central processing units with appropriate analog interfaces for implementation of the primary control system, and the attitude estimation algorithm. Preliminary results of some slewing control experiments are given. Author

N87-24512*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RESEARCH IN SLEWING AND TRACKING CONTROL
Jer-Nan Juang and James D. Turner (Cambridge Research Associates, Mass.) *In its* NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 869-880 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 22B

Technology areas are identified in which better analytical and/or experimental methods are needed to adequately and accurately control the dynamic responses of multibody space platforms such as the Space Station and the Radiometer Spacecraft. A generic space station model is used to experimentally evaluate current control technologies and a radiometer spacecraft model is used to numerically test a new theoretical development for nonlinear three-axis maneuvers. Active suppression of flexible body vibrations induced by large angle maneuvers is studied with multiple torque inputs and multiple measurement outputs. These active suppression tests identify the hardware requirements and adequacy of various controller designs.
Author

N87-24513*# University of Southern California, Los Angeles. Dept. of Civil Engineering.
EVALUATION OF ON-LINE PULSE CONTROL FOR VIBRATION SUPPRESSION IN FLEXIBLE SPACECRAFT Final Technical Report
Sami F. Masri 13 Jul. 1987 32 p
(Grant NAG1-636)
(NASA-CR-180391; NAS 1.26:180391; USC-53-4507-0031)
Avail: NTIS HC A03/MF A01 CSCL 22B

A numerical simulation was performed, by means of a large-scale finite element code capable of handling large deformations and/or nonlinear behavior, to investigate the suitability of the nonlinear pulse-control algorithm to suppress the vibrations induced in the Spacecraft Control Laboratory Experiment (SCOLE) components under realistic maneuvers. Among the topics investigated were the effects of various control parameters on the efficiency and robustness of the vibration control algorithm. Advanced nonlinear control techniques were applied to an idealized model of some of the SCOLE components to develop an efficient algorithm to determine the optimal locations of point actuators, considering the hardware on the SCOLE project as distributed in nature. The control was obtained from a quadratic optimization criterion, given in terms of the state variables of the distributed system. An experimental investigation was performed on a model flexible structure resembling the essential features of the SCOLE components, and electrodynamic and electrohydraulic actuators were used to investigate the applicability of the control algorithm with such devices in addition to mass-ejection pulse generators using compressed air.
B.G.

N87-24514# Aeritalia S.p.A., Naples (Italy). Space Systems Group.
ATTITUDE AND ORIENTATION CONTROL SYSTEM (AOCS) TASKS ON RENDEZVOUS AND DOCKING (RVD) (DOCKING-UNDOCKING PHASES). DOCKING-UNDOCKING PHASE ANALYSIS Final Report
Paris, France ESA Feb. 1986 138 p
(Contract ESA-4750/81-NL-AK(SC))
(LP-RP-AI-204-Vol-1; ESA-CR(P)-2313-Vol-1; ETN-87-99868)
Avail: NTIS HC A07/MF A01

The docking and undocking phases that comprise all operations leading from the first physical contact to the integral configuration of assembled spacecraft, and operations necessary to separate the two satellites in case of malfunctioning of one of them were analyzed. Mathematical models are obtained from this analysis in order to simulate these phases using the DCAP-1 program and to obtain preliminary design evaluations and requirements for the relevant docking subsystems. A probe-drogue type mechanism, including mechanical damping; and the docking between rigid interfaces are considered.
ESA

N87-24515 Colorado Univ., Boulder.
SIMULATION OF ON-ORBIT SATELLITE FRAGMENTATIONS Ph.D. Thesis
Darren Scott McKnight 1986 241 p
Avail: Univ. Microfilms Order No. DA8706439

The debris from nearly ninety satellites that have fragmented pose a serious hazard to all space systems in Earth orbit. A program has been developed which simulates fragmentation events whose magnitude, size distribution, velocity distribution, geometry, and location of breakup may all be controlled. This numerical model simulates in-orbit satellite fragmentations generating debris fragments across the entire size spectrum, many of which would be nondetectable by the NORAD Space Network. Monte Carlo methods are used to generate the size and velocity distributions of fragments according to hypothetical distributions derived from laboratory experiments. After breakup, the particles' orbits are propagated under the influence of drag and the J sub 2 gravitational term. This simulation program provides insight into the nontrackable debris population available through no other means. The simulation

of the Kosmos 1275 breakup supports the speculation that it is the first accidental collision-induced satellite breakup.
Dissert. Abstr.

N87-24516# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
INVESTIGATION FOR DAMPING DESIGN AND RELATED NONLINEAR VIBRATIONS OF SPACECRAFT STRUCTURES Final Report
E. Hilbrandt, I. Kolsch, and W. Charon Paris, France ESA Dec. 1985 438 p
(Contract ESTEC-5326/83-NL-PB(SC))
(EMSB-64/85; ESA-CR(P)-2329; ETN-87-99881) Avail: NTIS HC A19/MF A01

The sources of damping in spacecraft structures and substructures, their representation, analytical methods, and test procedures are investigated. Design concepts are developed and are verified on hardware applications. The description of the single damping sources is one of the main problems for the damping prediction method for substructures. The efficiency of the different damping sources differs by orders of magnitude. Damping prediction of substructures by the loss factor analysis method is sensitive to damping source characterization. The damping prediction of the substructures program developed, is written as a data base oriented batch program. A finite element calculation delivers all modal data for the total description of the structure including eigenvalues, eigenmodes, modal stresses, modal strains, and energies on element level. ESA

N87-24517# Systems Engineering Labs., Inc., Greenbelt, Md.
SPECTRAL FACTORIZATION AND HOMOGENIZATION METHODS FOR MODELING AND CONTROL OF FLEXIBLE STRUCTURES Final Report, Sep. 1984 - Sep. 1986
William H. Bennett, G. L. Blankenship, and H. G. Kwatny 15 Dec. 1986 188 p
(Contract F49620-84-C-0115)
(AD-A179726; SEI-TR-86-14; AFOSR-87-0502TR) Avail: NTIS HC A09/MF A01 CSCL 22B

This report describes continuum modeling and vibration control of flexible structures with application to active control of vibrations in large space structures. A comprehensive methodology is discussed for the construction of effective (linear) models for large composite structures consisting of various flexible members(e.g. beams, trusses, etc.) and rigid body elements. It is convenient to concentrate on frequency domain modeling. A systematic procedure is shown for computing the irrational transfer functions. Then by standard transform methods a complete hybrid model is developed. The methods were coded in a computer algebra system (SMP was used) which automated the model building process and produced Fortran code for numerical evaluation of the frequency responses. Effective continuum models of lattice structures with regular infrastructure can be obtained by a systematic procedure based on an asymptotic analysis of multiple scales called homogenization. This method is applied to several examples and accurate computation made of the required parameters of such continuum models somewhat more subtle than merely averaging over lattice cells. For the computation of distributed parameter control an optimal frequency domain method is based on solving an associated Wiener Hopf problem. The method employs effective numerical algorithms (e.g. FFT, etc.) to compute a certain spectral factorization of a possibly matrix valued (in the multiple control case) Hermittian, positive definite transform by sampling the frequency response. The control laws take the form of distributed state feedback with respect to a naturally defined, distributed state-space of functions over the spatial domain of the structure. GRA

N87-24518# General Accounting Office, Washington, D. C. National Security and International Affairs Div.
WEATHER SATELLITES: ECONOMIES AVAILABLE BY CONVERGING GOVERNMENT METEOROLOGICAL SATELLITES
Apr. 1987 79 p
(AD-A179969; GAO/NSIAD-87-107) Avail: NTIS HC A05/MF A01 CSCL 22B

There is considerable evidence to justify initiating action to converge the DMSP and TIROS systems. What has been lacking is sufficient impetus for the federal agencies involved to take such action. In the short term, planned procurement of the next set of satellites (DMSP S-16 through S-20 and TIROS K, L, and M) could be combined in fiscal year 1989 to start the convergence process. Long-range convergence efforts could also be initiated by integrating the National Oceanic and Atmospheric Administration's and the Air Force's requirements for a future generation of meteorological satellites. GRA

N87-24519# National Aerospace Lab., Emmeloord (Netherlands).
DYNAMICS OF FLEXIBLE SPACECRAFT: THE INTERNAL BALANCING APPROACH TOWARDS MATHEMATICAL MODEL ORDER REDUCTION
P. T. L. M. vanWoerkom 31 Oct. 1985 160 p
(PB87-162434; NLR-TR-85127-U) Avail: NTIS HC A08/MF A01 CSCL 22B

Mathematical models of the dynamics of spacecraft are needed to carry out numerical simulations, to gain insight into the characteristics of the spacecraft dynamics, and to synthesize control algorithms suitable for online system identification, estimation, and control. Increases in size and mechanical complexity of spacecraft result in increased complexity of the mathematical models. This results in turn in increased numerical simulation effort, increased difficulties in understanding the characteristics of the dynamics, and increased difficulties in synthesis and implementation of control algorithms. Reduction of the mathematical order of the open loop spacecraft dynamics model - with minimal loss of model accuracy - is therfore of paramount importance. GRA

N87-24520*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LARGE SPACE STRUCTURES TESTING
Henry Waites and H. Eugene Worley Jun. 1987 22 p
(NASA-TM-100306; NAS 1.15:100306) Avail: NTIS HC A02/MF A01 CSCL 22B

There is considerable interest in the development of testing concepts and facilities that accurately simulate the pathologies believed to exist in future spacecraft. Both the Government and Industry have participated in the development of facilites over the past several years. The progress and problems associated with the development of the Large Space Structure Test Facility at the Marshall Flight Center are presented. This facility was in existence for a number of years and its utilization has run the gamut from total in-house involvement, third party contractor testing, to the mutual participation of other Government Agencies in joint endeavors. Author

N87-24521*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DISTRIBUTED CONTROL USING LINEAR MOMENTUM EXCHANGE DEVICES
J. P. Sharkey, Henry Waites, and G. B. Doane, III (Control Dynamics Co., Huntsville, Ala.) Jun. 1987 50 p
(NASA-TM-100308; NAS 1.15:100308) Avail: NTIS HC A03/MF A01 CSCL 22B

MSFC has successfully employed the use of the Vibrational Control of Space Structures (VCOSS) Linear Momentum Exchange Devices (LMEDs), which was an outgrowth of the Air Force Wright Aeronautical Laboratory (AFWAL) program, in a distributed control experiment. The control experiment was conducted in MSFC's Ground Facility for Large Space Structures Control Verification (GF/LSSCV). The GF/LSSCV's test article was well suited for this experiment in that the LMED could be judiciously placed on the ASTROMAST. The LMED placements were such that vibrational mode information could be extracted from the accelerometers on the LMED. The LMED accelerometer information was processed by the control algorithms so that the LMED masses could be

accelerated to produce forces which would dampen the vibrational modes of interest. Experimental results are presented showing the LMED's capabilities. Author

N87-24522*# National Aeronautics and Space Administration, Washington, D.C.
X-RAY SATELLITE Status Report, 1st quarter 1987
Jun. 1987 54 p Transl. into ENGLISH of Statusbericht 1. Quartel 1987 (West Germany, DFVLR), 31 Mar. 1987 p 1-58 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20104; NAS 1.77:20104; DFVLR-RF-TN4; DFVLR-TN4/0235) Avail: NTIS HC A04/MF A01 CSCL 22B

As far as technical performance is concerned, the project is still within the previously arranged plan and as far as the launching possibilities are conserned, there is a change from the previous situation. A launch date in 1989 can only be realized with a Delta II, since there is no data available at present for the Atlas/Centaur as to whether and when production will resume. Author

N87-24523*# National Aeronautics and Space Administration, Washington, D.C.
DFVLR ROENTGEN SATELLITE Status Report, 4th quarter 1986
Jun. 1987 50 p Transl. into ENGLISH of Statusbericht, 4. Quartel, 1986 (West Germany, DFVLR) p 1-75 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20101; NAS 1.77:20101; DFVLR-RF-TN4) Avail: NTIS HC A03/MF A01 CSCL 22B

The entire engineering model is being concluded in the shuttle configuration. The flight model components are extensively included in the shuttle configuration and will not be changed until after a binding Atlas/Centaur (A/C) booster decision for the A/C configuration. The urgent projects for the altering of the shuttle configuration on the A/C configuration must be carried out before a binding Atlas/Centaur booster decision is completed. All other modification projects are being delayed until the presentation of a binding booster decision. Author

N87-24524*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DORSAL FIN FOR EARTH-TO-ORBIT TRANSPORTS Patent Application
Ian O. MacConochie, inventor (to NASA), Howard W. Stone, Jr., inventor (to NASA), and Richard W. Powell, inventor (to NASA) 12 Feb. 1987 9 p
(NASA-Case-LAR-13127-1; NAS 1.71:LAR-13127-1; US-Patent-Appl-SN-013769) Avail: NTIS HC A02/MF A01 CSCL 22B

A substantially trapezoidal dorsal fin is mounted on the centerline of the forebody of an aircraft. To obtain the desired dorsal fin, an airfoil with a high thickness-to-chord ratio is cut near the maximum thickness station thereof. The dorsal fin is attached to the aircraft by a device, such as a trunnion, which allows the dorsal fin to pivot about the attachment point. The dorsal fin is actively controlled and, in the deflected states thereof, applies a side force to the forebody of the aircraft, altering the flight direction. The novelty of this invention resides in the forward location of the dorsal fin which provides improved lateral directional control for an aircraft, especially an Earth-to-orbit transport. NASA

N87-24777# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
THE FIRST ESA REMOTE SENSING SATELLITE (STATUS AND OUTLOOK)
Hans Martin Braun and Erich H. Velten *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 329-334 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24797# Tokyo Univ. (Japan). Inst. of Industrial Science.
EARTH RESOURCES SATELLITE (ERS-1) PROJECT IN JAPAN
Shunji Murai *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 487-488 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-25031# Consiglio Nazionale delle Ricerche, Rome (Italy). Piano Spaziale Nazionale.
THE COLUMBUS PROGRAM
Alberto Loria *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 31-36 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

N87-24766# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Space Systems Group.
ADVANCED IMAGING SPECTROMETER FOR OCEAN COLOR/FLUORESCENCE MEASUREMENTS AND FURTHER APPLICATIONS
B. Kunkel, F. Blechinger, R. Lutz, and H. Winkenbach *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 237-246 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24779# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
MILLIMETER-WAVE ATMOSPHERIC SOUNDER (MAS) FOR USE ON THE SPACE SHUTTLE
W. Fricke *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 341-344 Prepared in cooperation with Max-Planck Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany, Bern Univ., Switzerland, and the Naval Research Lab., Washington DC (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24815# Technische Univ., Munich (West Germany). Faculty of Geosciences.
THE MODULAR OPTOELECTRONIC MULTISPECTRAL SCANNER (MOMS) PROGRAM OF THE BUNDESMINISTERIUM FUER FORSCHUNG UND TECHNOLOGIE (BMFT). MILESTONES IN THE DEVELOPMENT OF AN OPERATIONAL EARTH OBSERVATION SYSTEM
J. Bodechtel, D. Meissner, P. Seige, H. Winkenbach (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany), and J. Zilger *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 635-639 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N87-24525*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE NASA/USAF ARCJET RESEARCH AND TECHNOLOGY PROGRAM

James R. Stone and Edward S. Huston (Air Force Astrophysics Lab., Edwards AFB, Calif.) 1987 21 p Presented at the 23rd Joint Propulsion Conference, San Diego, Calif., 29 Jun. - 2 Jul. 1987; sponsored by AIAA, SAE, ASME and ASEE
(NASA-TM-100112; E-3656; NAS 1.15:100112; AIAA-87-1946) Avail: NTIS HC A02/MF A01 CSCL 21C

Direct current arcjets have the potential to provide specific impulses greater than 500 sec with storable propellants, and greater than 1000 sec with hydrogen. This level of performance can provide significant benefits for such applications as orbit transfer, station keeping, orbit change, and maneuvering. The simplicity of the arcjet system and its elements of commonality with state-of-the-art resistojet systems offer a relatively low risk transition to these enhanced levels of performance for low power (0.5 to 1.5 kW) station keeping applications. Arcjets at power levels of 10 to 30 kW are potentially applicable to orbit transfer missions. Furthermore, with the anticipated development of space nuclear power systems, arcjets at greater than 100 kW may become attractive. This paper describes the ongoing NASA/USAF program and describes major recent accomplishments. Author

N87-24526 Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).

RF ION THRUSTER RIT-35: OPERATION EXPERIENCE AND APPLICATION POSSIBILITIES

H. Bassner, H.-P. Berg, K. Groh, H. W. Loeb, and W. Schmidt 1986 17 p Presented at the 37th International Astronautical Federation Congress on Space: New Opportunities for All People, Innsbruck, Austria, 4-11 Oct. 1986 Submitted for publication
(MBB-UR-878/86; IAF-86-174; ETN-87-99939) Copyright Avail: Issuing Activity

An Electric Propulsion Module (EPM) based on the RF-ion engine RIT 35 has been studied to demonstrate its operational capabilities. The study, based on a multiple asteroid flyby mission, was finished in 1985. The tests with the RIT 35 engine laboratory model were performed successfully using mercury as the propellant. A power-to-thrust ratio including all losses of less than 22 W/mN has been achieved. The mission scenario for the application of electric propulsion has been changed from the multiple asteroid flyby mission (AGORA) to the more sophisticated Comet Nucleus Sample Return (CNSR) Mission, currently in preparation. ESA

N87-24527 Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Space Systems Group.

HERMES PROPULSION SYSTEM

Hans Immich, Helmut Hopmann, and Thierry Caussin (Societe Nationale Industrielle Aerospatiale, Les Mureaux, France) 1986 17 p Presented at the 37th International Astronautical Federation Congress on Space: New Opportunities for All People, Innsbruck, Austria, 4-11 Oct. 1986 Submitted for publication
(MBB-UR-879/86; IAF-86-185; ETN-87-99940) Copyright Avail: Issuing Activity

The Hermes main propulsion system design and the auxiliary propulsion system design are shown. The design is based on storable bipropellant engines, with 20 kN main engines, and 200 N thrusters. Operational requirements and a flow scheme are outlined. ESA

N87-24528# Science Research Council, Chilton (England). Rutherford Appleton Lab.

A DESIGN STUDY ON A MULTI-STAGE STIRLING CYCLE COOLER FOR SPACE APPLICATIONS

T. W. Bradshaw, S. F. J. Read, and D. A. Cragg Paris, France ESA Jul. 1986 127 p
(Contract ESA-6342/85-NL-PB(SC))
(ESA-CR(P)-2301; ETN-87-99864) Avail: NTIS HC A07/MF A01

The requirements for a low temperature two-stage Stirling cycle cooler are discussed, and a specification is given. Techniques for analyzing the cycle are considered, and a model for the single stage cooler is extended to the two-stage cooler. Parasitic losses which limit the performance of the cooler are estimated for the single and two-stage cooler. Their relative magnitudes as a function of temperature are calculated. The results of the calculations are compared with the performance of a prototype two-stage cooler. The possibility of increasing the size of the cooler is also considered, and its performance predicted. The applicability of candidate regenerator materials is evaluated. ESA

N87-24529# United Kingdom Atomic Energy Authority, Harwell (England).

RADIOISOTOPE GENERATORS FOR SPACE PROBES Final Report

J. Myatt Paris, France ESA Oct. 1985 117 p
(Contract ESTEC-4455/80-NL-JS(SC))
(ESA-CR(P)-2310; ETN-87-99865) Avail: NTIS HC A06/MF A01

The feasibility of setting up the production of small radioisotope power sources (250 W(e)) in Europe for use in the ESA space program was assessed. It is concluded that it is necessary to use a radioisotope fuelled generator with a thermoelectric convertor at the power level under consideration. Although development of individual components is needed, there is the capability to mount such a program in Europe. Cost estimates for a plutonium 238 generator are provided. ESA

N87-24530# Alcatel Thomson Espace, Toulouse (France).

ASSESSMENT OF SPACE STATION POWER SYSTEM Final Report

Paris, France ESA Oct. 1986 210 p
(Contract ESA-5170/85-NL-AN(SC))
(ATES-AN-86/466; ESA-CR(P)-2355; ETN-87-99889) Avail: NTIS HC A10/MF A01

It is shown that for large power spacecraft exceeding 10 KW user power, the distributed voltage must be a trade-off between mass of power system elements, transmission efficiency, plasma losses, component technology availability, and safety. The optimum voltage is 150 V. Simulation results indicate that the best electrical, mechanical, and thermal performances are available with an unregulated bus power system and the worst ones with the regulated bus concept, the sunlight regulated bus system data being very close to the latter concept. The substandard performance of the regulated bus voltage configuration is explainable by the fact that the simulation software is restricted to the power system platform simulation and does not take into account the important part of the active power distribution (voltage regulators on every user network) which is hidden in the user power profile. In spite of the contradictory results of the configuration evaluation, the regulated bus concept is advocated as power system configuration for the Space Station at 150 V + or - 10%. ESA

N87-24531*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DEVELOPMENT OF AN ADVANCED PHOTOVOLTAIC CONCENTRATOR SYSTEM FOR SPACE APPLICATIONS

Michael F. Piszczor, Jr. and Mark J. ONeill (ENTECH Corp., Dallas-Fort Worth Airport, Tex.) 1987 16 p Prepared for presentation at the 22nd Intersociety Energy Conversion Engineering Conference, Philadelphia, Pa., cosponsored by AIAA, ANS, ASME, SAE, IEEE, ACS, and AIChE

(NASA-TM-100101; E-3637; NAS 1.15:100101; AIAA-87-9034) Avail: NTIS HC A02/MF A01 CSCL 10B

Recent studies indicate that significant increases in system performance (increased efficiency and reduced system mass) are possible for high power space based systems by incorporating technological developments with photovoltaic power systems. The Advanced Photovoltaic Concentrator Program is an effort to take advantage of recent advancements in refractive optical elements. By using a domed Fresnel lens concentrator and a prismatic cell cover, to eliminate metallization losses, dramatic reductions in the required area and mass over current space photovoltaic systems are possible. The advanced concentrator concept also has significant advantages when compared to solar dynamic Organic Rankine Cycle power systems in Low Earth Orbit applications where energy storage is required. The program is currently involved in the selection of a material for the optical element that will survive the space environment and a demonstration of the system performance of the panel design. Author

N87-24532# Technische Univ., Berlin (West Germany). Inst. fuer Luft- und Raumfahrt.

PRELIMINARY ANALYSIS OF A PROTOTYPE SPACE SOLAR POWER SYSTEM

Bernd Johenning, Heinz-Hermann Koelle, Thomas Altmann, Thomas Dreer, Thomas Eckardt, Andreas Jain, Olaf Kerinnis, Michael Krueger, Michael Mielke, and Nicolaus Millin 15 Oct. 1986 35 p In GERMAN; ENGLISH summary

(ILR-Mitt-168; ETN-87-99672) Avail: NTIS HC A03/MF A01

The results of a study project on a 500MW space solar power unit are summarized. The analysis concentrated on the assembly process to be carried out in geostationary orbit. The satellite power unit and the required infrastructure (manufacturing plant, habitat, space port, space tugs, etc.) have a total mass of 10,000 metric tons. It is estimated that the assembly of this complex takes 40 months at an average crew of 40 at the assembly site. The logistics support requires 134 flights of a space freighter with a payload of 100 metric tons, and 29 passenger flights. The transition from prototype assembly to large scale manufacturing is discussed. ESA

N87-24533# Technische Hogeschool, Delft (Netherlands). Dept. of Electrical Engineering.

STATUS OF SERIES-RESONANT POWER CONVERSION WITH HIGH INTERNAL FREQUENCIES. SUPPORT IN DEFINITION OF SPACE STATION POWER INTERFACE

J. Benklaassens and Jeroen vanDuivenbode Paris, France ESA 1986 99 p

(Contract ESA-5170/85-NL-AN(SC))

(ESA-CR(P)-2319; ETN-87-99875) Avail: NTIS HC A05/MF A01

The principles of series-resonant power conversion are reviewed. Optimization of series-resonant converters is discussed. The role the series-resonant converter can play in the power system of the Columbus space station is assessed. Its implementation conversion gives dc conversion practically all the advantages of ac conversion, due to the fact that the series-resonant conversion process is based on the transfer of electric energy by an ac internal waveform. ESA

N87-24534# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

COMBUSTION INSTABILITY IN SOLID PROPELLANT ROCKETS Annual Technical Report, 1 May 1986 - 24 Feb. 1987

E. W. Price and G. A. Flandro 24 Feb. 1987 112 p

(Contract F49620-86-C-0005)

(AD-A179701; AFOSR-87-0459TR) Avail: NTIS HC A06/MF A01 CSCL 21I

This project concerns assembly, synthesis and comprehensive presentation of information on combustion instability in solid rockets, in the form of a reference book. The format is chosen to make the book suitable for a wide audience of readers including propulsion program managers, motor designers, propellant chemists, test engineers, and combustion specialists. The diversity of audience is accommodated by opening with general introductory chapters for nonspecialist, with progression into more applied issues, such as experimental methods and remedial measures. All chapters open with Introductions that give a relatively non-technical statement of the problem and content, and end with a qualitative summary of what was done in the chapter. An extensive bibliography is included, and supplemented by a more complete, computer based bibliography with search-retrieval capability. GRA

N87-24535*# Tennessee Univ. Space Inst., Tullahoma.

HIGH TEMPERATURE MEASUREMENT OF WATER VAPOR ABSORPTION Final Report

Dennis Keefer, J. W. L. Lewis, and Richard Eskridge 31 Jul. 1985 101 p

(Contract NAS8-34320)

(NASA-CR-179128; NAS 1.26:179128) Avail: NTIS HC A06/MF A01 CSCL 21C

An investigation was undertaken to measure the absorption coefficient, at a wavelength of 10.6 microns, for mixtures of water vapor and a diluent gas at high temperature and pressure. The experimental concept was to create the desired conditions of temperature and pressure in a laser absorption wave, similar to that which would be created in a laser propulsion system. A simplified numerical model was developed to predict the characteristics of the absorption wave and to estimate the laser intensity threshold for initiation. A non-intrusive method for temperature measurement utilizing optical laser-beam deflection (OLD) and optical spark breakdown produced by an excimer laser, was thoroughly investigated and found suitable for the non-equilibrium conditions expected in the wave. Experiments were performed to verify the temperature measurement technique, to screen possible materials for surface initiation of the laser absorption wave and to attempt to initiate an absorption wave using the 1.5 kW carbon dioxide laser. The OLD technique was proven for air and for argon, but spark breakdown could not be produced in helium. It was not possible to initiate a laser absorption wave in mixtures of water and helium or water and argon using the 1.5 kW laser, a result which was consistent with the model prediction. Author

N87-24536*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

RESISTOJET PLUME AND INDUCED ENVIRONMENT ANALYSIS M.S. Thesis - Case Western Reserve Univ.

David J. Hoffman May 1987 60 p

(NASA-TM-88957; E-3410; NAS 1.15:88957) Avail: NTIS HC A04/MF A01 CSCL 21H

The source flow method developed by G.A. Simons for calculating the far field plume density produced by high thrust rocket nozzles is modified and applied to low thrust resistojet nozzles with Reynolds numbers on the order of 4000 to 7000. Simons' original method and the modified analysis are compared to mass flux measurements taken by Chirivella in a JPL vacuum tank facility. Results of the comparison show the modified analysis presented more accurately predicts the mass flux at large angles from the nozzle centerline than Simons' original method. The modified Simons analysis is then used to calculate the plume structure and two contamination parameters, number column density and back flow, for five nozzle geometries representative of Space Station resistojets. Author

N87-24537# Aeronautical Research Labs., Melbourne (Australia).

THRUST CONTROL WITH HIGH PRESSURE RATIO EJECTOR AUGMENTORS

S. C. Favaloro Aug. 1986 41 p

(ARL-AERO-PROP-R-173; AR-004-500) Copyright Avail: NTIS HC A03/MF A01

The possibility of utilizing the entrained secondary air in a thrust augmenting ejector for thrust control purposes was examined in a series of experiments using high pressure unheated air as the primary jet. Four control concepts, namely duct venting, axially

deployed spoilers, radially deployed tabs and duct swivelling, were investigated and results have shown that all systems provide some degree of thrust vector and thrust magnitude control. Maximum Thrust Vector Control (TVC) in yaw/pitch mode was available with duct swivelling, while radial tabs provided maximum Thrust Magnitude Control (TMC). Author

N87-25119# Justus Liebig-Universitaet, Giessen (West Germany). Inst. of Physics.
ION PROPULSION SYSTEMS
Horst W. Loeb *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 75-92 (For primary document see N87-25109 18-90)
Copyright Avail: NTIS HC A11/MF A01

23 CHEMISTRY AND MATERIALS (GENERAL)

N87-24538*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A FAST DATA ACQUISITION SYSTEM FOR THE STUDY OF TRANSIENT EVENTS BY HIGH REPETITION RATE TIME-OF-FLIGHT MASS SPECTROMETRY
K. A. Lincoln and R. D. Bechtel (Ferretec, Inc., Milpitas, Calif.) Oct. 1986 11 p
(NASA-TM-88374; A-86428; NAS 1.15:88374) Avail: NTIS HC A02/MF A01 CSCL 07D

Recent advances in commercially available data acquisition electronics embodying high speed A/D conversion coupled to increased memory storage have now made practical (at least within time intervals of a third of a millisecond or more) the capturing of all of the data generated by a high repetition rate time-of-flight mass spectrometer producing complete spectra every 25 to 35 microseconds. Such a system was assembled and interfaced with a personal computer for control and management of data. The applications are described for recording time-resolved spectra of individual vapor plumes induced from the pulsed-laser heating of material. Each laser pulse triggers the system to generate automatically a 3-dimensional (3-D) presentation of the time-resolved spectra with m/z labeling of the major mass peaks, plus an intensity versus time display of both the laser pulse and the resulting vapor pulse. The software also permits storing of data and its presentation in various additional forms. Author

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

N87-24539# Science and Engineering Associates, Inc., Seattle, Wash.
DETERMINATION OF ELECTRICAL PROPERTIES OF GROUNDING, BONDING AND FASTENING TECHNIQUES FOR COMPOSITE MATERIALS Final Technical Report, Sep. 1984 - Dec. 1985
William W. Cooley Apr. 1987 81 p
(Contract DTFA03-84-C-00065)
(DOT/FAA/CT-86/8) Avail: NTIS HC A05/MF A01

This report documents the results from a limited study of Electrical Parameters of Composite Materials. These efforts provided an evaluation of grounding and bonding test methods for metal, metal honeycomb, and advanced composite materials. A review of the electrical currents in the bonding and grounding paths on aircraft concluded that the lightning environment is the most severe followed by power system faults and onboard HF radio. It is recommended that the conventional 2.5 milliohm grounding and bonding requirement may be relaxed providing that special tests are conducted on the structure and subassemblies that enter into the grounding and bonding current paths. These tests are defined and recommendations made for advanced structures. A limited analysis of published test results concluded that good agreement may be possible between predicted values and test results for complete structures, subassemblies, and components. Author

N87-24540# Societe Nationale des Poudres et Explosifs, Vert-Le-Petit (France).
TENSILE STRENGTH, SPECIMENS WITH HOLES, FOR COMPOSITES WITH DA 506 MATRIX [RESISTANCE A LA TRACTION TROUEE DES COMPOSITES A MATRICE DA 506]
Christiane Gourdin 8 Sep. 1986 19 p In FRENCH
(Contract STPA-86-96-00-400-47-75-86)
(ETN-87-99628) Avail: NTIS HC A02/MF A01

The carbon fiber-matrix interface effects on holed specimens, which may depend on parameters such as type and concentration of fiber finish were investigated. The results show that finish is not the only factor affecting holed specimens performance. For equivalent finish and geometry conditions, the DA506 resin shows a better performance with higher elongation fibers. ESA

N87-24541 Illinois Univ., Chicago.
EIGENFUNCTIONS AT A SINGULAR POINT IN TRANSVERSELY ISOTROPIC MATERIALS AND COMPOSITES UNDER AXISYMMETRIC DEFORMATIONS Ph.D. Thesis
Yijian Jin 1986 78 p
Avail: Univ. Microfilms Order No. DA8705188

In finding stress distribution in an elastic solid numerically by a finite element scheme, special elements are used at a singular point such as a notch or a crack in which the singular nature of the stress is given by an analytical expression. When a two-dimensional elastic body containing a notch or a crack is under a plane stress or plane strain deformation, the asymptotic solution of the stress near the apex of notch or crack is simply a series of eigenfunctions of the form rho sup delta (psi, delta) in which (rho, psi) is the polar coordinate with origin at the apex and delta is the eigenvalue. If the body is a three-dimensional elastic solid that contains axisymmetric notches or cracks and subjected to an axisymmetric deformation, the eigenfunctions associated with an eigenvalue contain not only the rho sup delta term, but also rho sup delta +1, rho sup delta +2... terms. Therefore, the second and higher-order terms of the asymptotic solution are not simply the second and subsequent eigenfunctions. Presented here are the eigenfunctions for transversely isotropic materials under an axisymmetric deformation. The degenerate materials in which the eigenvalues, p sub 1, p sub 2 of the elasticity constants are also considered. The latter include the isotropic material as a special case. The solution is applied to eigenfunctions at a singular point in composites. To avoid the unrealistic inter-penetration of displacement at an interface crack, the assumption of a contact zone is introduced. Alternative formulas for the singularities at an interface crack with contact are derived by using the Stroh formalism. Dissert. Abstr.

N87-24542 Florida Univ., Gainesville.
STRESS ANALYSIS OF IMPACTED LAMINATED COMPOSITE PLATES WITH A HYBRID STRESS FINITE ELEMENT METHOD Ph.D. Thesis
Wen-Jinn Liou 1986 196 p
Avail: Univ. Microfilms Order No. DA8704189

In view of the increasing interest in using composite materials for aerospace structures, the analysis of laminated composite plates becomes essential. A systematic study of the response of laminated plates subject to static, dynamic, and impact loading was conducted using a hybrid stress finite element method. The hybrid stress model was based on the modified Reissner principle. The transverse shear effects, as well as the coupling effects of stretching and bending, were included in the model. The validity of the hybrid stress model was determined by comparing the numerical results with existing exact analytical solutions. The dynamic response of a laminated plate impacted by a projectile was analyzed. The force distributions were based on the principle

of linear impulse and momentum and the Hertzian impact law. The transverse deflection at the center of the laminate was in good agreement with the deflection determined experimentally. The laminate bending stiffness, projectile velocity, and laminate thickness had effects on the deflection and stress distributions. The interlaminar transverse shear stresses and normal stress were incorporated into a quadratic failure criterion to perform the failure analysis. The results showed that the delamination crack was initiated near the area of impact and propagated outward. It also showed that the delamination crack possibly occurred simultaneously for both interfaces. Dissert. Abstr.

N87-24543 Virginia Polytechnic Inst. and State Univ., Blacksburg.
ANALYTICAL SOLUTIONS FOR THE STATICS AND DYNAMICS OF RECTANGULAR LAMINATED COMPOSITE PLATES USING SHEARING DEFORMATION THEORIES Ph.D. Thesis
Ahmed Adel Khdeir 1986 191 p
Avail: Univ. Microfilms Order No. DA8704682

The Levy-type analytical solutions in conjunction with the state-space concept are developed for symmetric laminated composite rectangular plates. Combinations of simply-supported, free and clamped boundary conditions are considered. The solutions are obtained for the first-order and higher-order theories in predicting the transverse deflections and stresses. Numerical results are presented for various boundary conditions, aspect ratios, lamination schemes and different loadings. The development of these theories accomplished in general coordinates allow one to fulfill both the invariance requirements and to derive the relevant equations in any convenient planar systems of coordinates. The dynamic response problems are analyzed in the framework of higher order theories where the effects of transverse normal stress and rotary inertia forces are evaluated. The comparison between the theories as well as previous results is reported.
Dissert. Abstr.

N87-24544 Nebraska Univ., Lincoln.
A PROBABILISTIC FATIGUE FAILURE ANALYSIS OF LAMINATED COMPOSITE MATERIALS Ph.D. Thesis
John Colin Wright 1986 98 p
Avail: Univ. Microfilms Order No. DA8704565

A study of the prediction of the fatigue life of composite materials is presented. Failure is characterized by the accumulation of plastic work to a critical level. Energy accumulation is obtained by calculating hysteretic energy using a probabilistic approach. This approach uses a two parameter model to describe continuous random yielding within an orthotropic material. The two parameters are the mean and standard deviation of the distribution of the yielding elements. The yield distributions are defined with respect to logarithmic strain. It is assumed that the limiting value of accumulated plastic strain energy is constant and is obtained from integration of the plastic portion of the random macroelement up to failure. Dissert. Abstr.

N87-24545# Construcciones Aeronauticas S.A., Madrid (Spain). Div. de Proyectos.
EVALUATION OF THE IMPACT RESISTANCE OF COMPOSITE MATERIAL FIBER REINFORCEMENT [EVALUACION DE LA RESISTENCIA AL IMPACTO DE REFUERZOS EN MATERIALES COMPUESTOS]
E. Redondo 14 Oct. 1986 13 p In SPANISH
(Informe-I-153/86; ETN-87-99846) Avail: NTIS HC A02/MF A01

The impact resistance of carbon fiber reinforced composites was studied in order to choose the best materials and structure patterns for high impact exposed elements design. The basic test configurations are described as well as the thermal cycle and test conditions. It is found that the inclusion of glass fiber in the structure design improves the impact behavior. ESA

N87-24546# Cambridge Univ. (England). Dept. of Engineering.
CRACK ADVANCEMENT IN A CARBON FIBRE-EPOXY COMPOSITE OBSERVED BY DYNAMIC SCANNING ELECTRON MICROSCOPY
M. T. Kortschot, Peter W. R. Beaumont, W. C. Nixon, and B. C. Breton Feb. 1987 11 p
(CUED/C-MATS/TR136; ISSN-0309-6505) Avail: NTIS HC A02/MF A01

Instrumented tensile tests of double edge notched carbon fiber-epoxy specimens were performed inside the vacuum chamber of a scanning electron microscope. The formation of damage at the notch tip was observed and its effect on laminate strength was measured for a variety of crossply layups. Of all the damage processes observed, splitting in the 0 degree plies was found to have the greatest influence on laminate strength. Author

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N87-24547# Sandia National Labs., Albuquerque, N. Mex.
THERMOCHEMISTRY OF COMBUSTION IN LEAN MIXTURES OF HYDROGEN AND AIR
V. L. Behr and D. C. Chou Oct. 1986 14 p Presented at the 22nd AIAA Thermophysics Conference, Honolulu, Hawaii, 8 Jun. 1987 Prepared in cooperation with United International Engineering, Inc., Albuquerque, N. Mex.
(Contract DE-AC04-76DP-00789)
(DE87-000570; SAND-86-2411C; CONF-870623-1) Avail: NTIS HC A02/MF A01

To understand the phenomenon of combustion, it is necessary to understand how the coupled set of chemical reactions that describes the combustion process behaves. The latter is modeled mathematically using finite rate kinetics and the usual non-Arrhenius expression for the rate constants. The set of chemical reactions considered is that describing the combustion of lean mixtures of hydrogen and air, including reactions involving third bodies or a bath gas. A numerical integration routine is used to solve the set of stiff, coupled, ordinary, nonlinear differential equations describing the combustion problem. The importance of each species and reaction is investigated by examining the relative reaction rates and species concentrations. Of the original set of 18 reactions associated with the combustion of hydrogen in air, 10 reactions are found to be unimportant in describing the overall combustion process. Details are given in terms of the chemical mechanisms of combustion as to why the 10 reactions are unimportant. Numerical results from a one-dimensional combustion problem are presented as a means of verifying the validity of the simplified set of 8 reactions even with the presence of spatial effects. These results are also compared to some experimental results. DOE

N87-24548# Adiabatics, Inc., Columbus, Ind.
COMBUSTION CHARACTERISTICS OF COAL FUELS IN ADIABATIC DIESEL ENGINES
R. Kamo, R. M. Kakwani, M. E. Woods, and E. Valdmanis Jun. 1986 87 p
(Contract DE-AC21-84MC-21099)
(DE86-015782; DOE/MC/21099-2167) Avail: NTIS HC A05/MF A01

An experimental investigation was conducted to determine the combustion characteristics of coal fuels in adiabatic diesel engines. Engine testing was carried out by the fumigation of a fine coal powder to the intake of an insulated and uncooled single cylinder diesel engine. Three types of fuel were used: Diesel fuel No. 2 (DF-2), Dual fuel (DF-2 + Coal), and Coal fuel. Excellent combustion characteristics for coal fuels were obtained in an adiabatic engine operating at high temperature. The high temperature engine with the ignition chamber permitted engine

operation on 100% coal fuel without any external ignition aids or compression ignition. With the addition of a glow plug, the coal fueled engine was successfully cold started. The problems encountered during the engine tests include: variation in the engine speed and load due to non-uniform coal flow rate by the feed system, contamination of the lubricating oil with fine coal powder, and wear of conventional piston rings. An improved lubrication system with a centrifugal by-pass filter was designed. Author

N87-24549*# Sverdrup Technology, Inc., Cleveland, Ohio.
DECOUPLED DIRECT METHOD FOR SENSITIVITY ANALYSIS IN COMBUSTION KINETICS Final Report
Krishnan Radhakrishnan Jun. 1987 17 p Presented at the 6th International Symposium on Computer Methods for Partial Differential Equations, Bethlehem, Pa., 23-25 Jun. 1987; sponsored by International Association for Mathematics and Computers
(Contract NAS3-24105)
(NASA-CR-179636; E-3635; NAS 1.26:179636) Avail: NTIS HC A02/MF A01 CSCL 21B

An efficient, decoupled direct method for calculating the first order sensitivity coefficients of homogeneous, batch combustion kinetic rate equations is presented. In this method the ordinary differential equations for the sensitivity coefficients are solved separately from , but sequentially with, those describing the combustion chemistry. The ordinary differential equations for the thermochemical variables are solved using an efficient, implicit method (LSODE) that automatically selects the steplength and order for each solution step. The solution procedure for the sensitivity coefficients maintains accuracy and stability by using exactly the same steplengths and numerical approximations. The method computes sensitivity coefficients with respect to any combination of the initial values of the thermochemical variables and the three rate constant parameters for the chemical reactions. The method is illustrated by application to several simple problems and, where possible, comparisons are made with exact solutions and those obtained by other techniques. Author

N87-24550# California Univ., Berkeley. Dept. of Mechanical Engineering.
PERTURBED BOUNDARY LAYER DIFFUSION FLAMES
James Alfred Ang Mar. 1987 138 p
(Contract NBS-60-NANB-5D-0552)
(PB87-179222; NBS/GCR-87/526) Avail: NTIS HC A07/MF A01 CSCL 21B

Thermal cracking is shown to have a significant effect on the temperature profiles in a boundary layer diffusion flame. In the study, measurements of temperature profiles in a sooting free flow flame are compared with classic flame sheet model results. This comparison reveals a large overprediction of temperatures in the region between the fuel surface and the flame. The principal cause of this overprediction is the neglect of thermal cracking in the flame sheet model. A second possible cause for the temperature overprediction is the sink effect of radiative heat transfer from soot in the boundary layer. This effect and the effects of wall emission and normal buoyancy on a horizontal boundary layer diffusion flame are studied by perturbing the cracking sheet solution. The principal effect of soot radiation is an increased blowing rate at the wall. This blowing is offset by the radiation wall emission. The postulated sink effect of soot emission is negligible. The major buoyancy effect is primarily the inducement of a velocity overshoot. GRA

N87-25125# European Space Agency, Paris (France).
PHOTOCHEMICAL STUDIES OF S2 FORMATION AND THEIR IMPLICATIONS ON THE SOURCE AND EVOLUTION OF COMETS
R. J. A. Grim and J. M. Greenberg *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 143-151 (For primary document see N87-25109 18-90)
Copyright Avail: NTIS HC A11/MF A01

N87-25128# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Chemie 1.
TEMPERATURE RECOMMENDATION TO PRESERVE A CHEMICAL STATUS QUO OF COMETARY SAMPLES
K. Roessler and B. Nebeling *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 165-168 (For primary document see N87-25109 18-90)
Copyright Avail: NTIS HC A11/MF A01

N87-25129# Centre National de la Recherche Scientifique, Saint Martin d'Heres (France). Lab. de Glaciologie et Geophysique de l'Environnement.
RISK OF PHYSICAL AND CHEMICAL ALTERATION OF COMET NUCLEUS SAMPLES DURING TRANSFER TO EARTH
J. Ocampo, B. Schmitt, and J. Klinger *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 169-171 (For primary document see N87-25109 18-90)
(Grant ATP-47/89)
Copyright Avail: NTIS HC A11/MF A01

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N87-24551# Argonne National Lab., Ill.
THERMOMECHANICAL FATIGUE OF TYPE 304 STAINLESS STEEL
S. Majumdar Dec. 1986 23 p Presented at the 5th National Congress on Pressure Vessels and Piping, San Diego, Calif., 28 Jun. 1987
(Contract W-31-109-eng-38)
(DE87-006995; CONF-870636-4) Avail: NTIS HC A02/MF A01

Results are summarized for thermomechanical fatigue tests conducted between 427 and 593 C on type 304 stainless steel. The isothermal continuous cycling fatigue behavior of type 304 stainless steel varies from a minimal dependence of life on strain rate at the lowest temperature (427 C) to a significant strain rate effect on life at the highest temperature (593 C). On the other hand, thermomechanical fatigue tests conducted between the same two temperature limits show a complex behavior dependent on temperature, strain, and their phases during cycling. In most cases, for cycles at relatively high strain ranges (greater than or equal to 0.5%), in-phase thermomechanical cycling is the most damaging followed by isothermal cycling at the highest temperature, which in turn is followed by out-of-phase thermomechanical cycling, and finally, the least damaging of all, isothermal cycling at the lowest temperature of the cycle. The failure mechanisms in these tests can vary significantly. The damage rate equations proposed for predicting lives of isothermal fatigue tests can be successfully used to predict the lives of all the thermomechanical tests conducted to date on the basis of isothermal test parameters. The approach also predicts the observed fracture modes correctly. DOE

N87-24552# Massachusetts Inst. of Tech., Cambridge.
MECHANISMS OF TRANSFORMATION TOUGHENING Progress Report, 1 Jan. - 31 Jul. 1987
G. B. Olson and D. M. Parks 1987 20 p
(Contract DE-FG02-84ER-45154)
(DE87-007379; DOE/ER-45154/T2) Avail: NTIS HC A02

Research is being done on transformation plasticity and toughening in steels and on finite-element modeling of transformation toughening in steels. In the analysis of nonuniform flow and constitutive behavior in TRIP steels, a finite-element analysis was performed to model these steels during simple tension tests. Crack-tip metallographic observations have been performed on the precipitation-hardened 31 Ni steel. Experimental alloys under study are discussed. DOE

N87-24553# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Corrosion Subcommittee of the Structures and Materials Panel.
AGARD CORROSION HANDBOOK. VOLUME 2: AIRCRAFT CORROSION CONTROL DOCUMENTS: A DESCRIPTIVE CATALOGUE
J. J. DeLuccia, R. D. Gergar, and E. J. Jankowsky (Jaylords, Inc., Philadelphia, Pa.) Mar. 1987 48 p
(AGARD-AG-278-Vol-2; AGARDograph-278; ISBN-92-835-1545-5) Avail: NTIS HC A03/MF A01

This is the second part of a handbook of Aircraft Corrosion produced by the AGARD Structures and Materials Panel. This volume catalogs sources of information and requirements for corrosion control obtained from documents issued by NATO, France, UK, and US authorities. IATA (International Air Transport Association) documents are also cited as a commercial reference. Author

N87-24554# International Centre for Theoretical Physics, Trieste (Italy).
NATURE OF THE EIGENSTATES NEAR THE MOBILITY EDGE IN RANDOM BINARY ALLOYS
L. Dahmani, M. Sebbani, and A. Brezini Jun. 1986 15 p
(DE87-701769; IC-86/88) Avail: NTIS (US Sales Only) HC A02/MF A01

Presented is a calculation of the probability of non-diffusion and the localization length in a disordered Cayley tree in the case of a binary alloy distribution for the site energies. Particular attention is paid to the states near the mobility edge E(sub c) and numerical data for the critical exponent upsilon of the localization length are deduced. DOE

N87-24555# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique des Materiaux.
CYCLIC OXIDATION BEHAVIOR AND HOT CORROSION OF THE PROTECTED SINGLE CRYSTAL CMSX 2 SUPERALLOY [COMPORTEMENT EN OXYDATION CYCLIQUE ET CORROSION A CHAUD DU SUPERALLIAGE MONOCRISTALLIN CMSX 2 PROTEGE]
R. Mevrel, S. Naveos, and C. Duret Jun. 1986 55 p In FRENCH
(Contract DRET-85-34-001)
(ONERA-RT-4/3633-M; ETN-87-99619) Avail: NTIS HC A04/MF A01

The heat corrosion in the presence of SO4Na2 and cyclic oxidation were studied for several types of surface protective coatings. The protection included aluminum, aluminum modified with Pt or Cr, plasma projected MCrAlY alloys and cathodic coatings. The results show the positive effects of the inclusion of yttrium and Pt in the coating. The Al coating is efficient against heat corrosion. The positive effects of Cr addition are discussed. ESA

N87-24556*# Grumman Aerospace Corp., Bethpage, N.Y. Materials and Structural Mechanics Dept.
DIRECTIONAL SOLIDIFICATION OF Bi-Mn ALLOYS USING AN APPLIED MAGNETIC FIELD Final Report, 1 Jan. 1984 - 31 Dec. 1986
J. L. DeCarlo and R. G. Pirich Apr. 1987 46 p
(Contract NAS8-36106)
(NASA-CR-179127; NAS 1.26:179127; RE-732) Avail: NTIS HC A03/MF A01 CSCL 11F

Off-eutectic compositions of Bi-Mn were directionally solidified in applied transverse magnetic fields up to 3 kG, to determine the effects on thermal and solutal convection. Plane front directional solidification of eutectic and near-eutectic Bi-Mn results in a two-phase rodlike morphology consisting of ferromagnetic MnBi rods in a Bi solid solution matrix. Compositions of either side of the eutectic were studied in growth orientations vertically up and down. Temperature gradient was monitored during growth by means of an in-situ thermocouple. For Bi-rich compositions, the magnetic field appeared to increase mixing as determined from thermal, morphological, chemical, and magnetic analyses. For Mn-rich compositions, morphological and chemical analyses suggest some reduction in mixing due to application of the magnetic force. The capability for carrying out directional solidification of Bi-Mn in high longitudinal magnetic fields was established. Author

N87-24557# Cambridge Univ. (England). Dept. of Engineering.
ON DENSIFICATION AND SHAPE-CHANGE DURING HOT ISOSTATIC PRESSING
W.-B. Li, M. F. Ashby, and K. E. Easterling (New South Wales Univ., Kensington, Australia) Mar. 1987 36 p
(CUED/C-MAT-TR135; ISSN-0309-6505) Avail: NTIS HC A03/MF A01

When the temperature of a powder compact is raised, heat diffuses inwards from the surface. If the compact is under pressure (as it is during HIPing), the surface layers start to densify, increasing the local thermal conductivity. Under certain conditions a densification front then propagates into the powder, and this leads to changes of shape of the compact, which is no longer identical to the preform shape. The conditions which lead to nonuniform densification are analyzed and the consequences are discussed, and compared with experiments. Author

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials*.

N87-24558# Rockwell International Corp., Thousand Oaks, Calif. Science Center.
TRANSFORMATION TOUGHENING OF CERAMICS Annual Report, 1 Sep. 1985 - 31 Aug. 1986
D. B. Marshall and F. F. Lange Jan. 1987 130 p
(Contract F49620-85-C-0143)
(AD-A179146; SC5444-AR; AFOSR-87-0323TR; AR-1) Avail: NTIS HC A07/MF A01 CSCL 11B

In situ optical observations during mechanical loading have been used to investigate R-curve behavior in a series for transformation toughened ceramics and to examine characteristics of the tetragonal-to-monoclinic transformation that is responsible for toughening. In high strength and high toughness materials, the strength is dictated by the R-curve and is independent of pre-existing flaws. The results explain observed strength-toughness relations in several zirconia systems (peak strength obtained at intermediate toughness) and are qualitatively consistent with predictions of fracture mechanics analysis of transformation toughening. Important insight into other microstructural influences of strength and toughness, and into factors that influence initiation and stabilization of the martensitic transformation were also obtained. Mechanisms of grain growth control, critical for fabricating transformation toughened ceramics, in the two-phase region of the Zirconium oxide/Yttrium oxide system were investigated by measuring phase partitioning and microstructural development during sintering of a metastable precursor with a very uniform initial distribution of Y2O3 additive. From the results it is suggested that partitioning begins with small compositional fluctuations between grains, and that strain energy resulting from lattic parameter mismatch inhibits grain boundary movement and hence grain growth. High strength zirconia fibers were fabricated by drawing from an acetate precursors. The fibers had uniform diameters and compositions that exhibited grain growth control and strengths up to 2.6 GPa were obtained. GRA

N87-24559# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
FOURIER TRANSFORM INFRARED SPECTROSCOPIC STUDY OF THERMAL AND ELECTRICAL AGING IN POLYURETHANE
Robert S. Bretzlaff and S. L. Sandlin 20 Mar. 1987 46 p
(Contract F04701-85-C-0086)
(AD-A179152; TR-0086(6925-08)-4; SD-TR-87-04) Avail: NTIS HC A03/MF A01 CSCL 07C

(AD-A179152; TR-0086(6925-08)-4; SD-TR-87-04) Avail: NTIS HC A03/MF A01 CSCL 07C

Many different polymeric insulations, such as silicons, epoxies, polyethylenes, etc., are in use. Unfortunately, these materials exhibit decreasing resistance to electrical stress with time. In order to characterize these degradation processes and to suggest materials changes that will ameliorate them, we are developing Fourier transform infrared spectroscopy (FTIR) techniques to look for molecular changes that occur before breakdown and which may therefore be used as a distant early-warning line for impending breakdown. GRA

N87-24560# Manlabs, Inc., Cambridge, Mass.

APPLICATION OF COMPUTER METHODS FOR CALCULATION OF MULTICOMPONENT PHASE DIAGRAMS OF HIGH TEMPERATURE STRUCTURAL CERAMICS Annual Report, 1 Mar. 1986 - 27 Feb. 1987

Larry Kaufman 27 Feb. 1987 38 p

(Contract F49620-84-C-0078)

(AD-A179167; AFOSR-87-0328TR) Avail: NTIS HC A03/MF A01 CSCL 11B

Computer Coupled Phase Diagrams and Thermochemical Data have been used to calculate the Titanium dioxiole-Aluminum oxide, TiO2-Silicon dioxide, TiO2-Calcium oxide, TiO2-Yttrium oxide quasi binary systems as well as ternary sections over a wide range of temperatures for the following systems, Hafnium oxide-Magnesium oxide-Y2O3, HfO2-CaO-Zirconium oxide SiO2-HfO2-Y2O3, MgO-SiO2-HfO2, TiO2-Al3O3-MgO, Al2O3-TiO2-SiO2, TiO2-Al2O3-HfO2, and MgO-SiO2-TiO2. GRA

N87-24561# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

AN ELECTRON MICROSCOPIC STUDY OF THE MORPHOLOGY OF CURED EPOXY RESIN Interim Report, Jul. 1982 - Jun. 1984

W. W. Adams, V. B. Gupta, L. T. Drzal, and R. Omlor Dec. 1986 40 p

(AD-A177995; AFWAL-TR-86-4029) Avail: NTIS HC A03/MF A01 CSCL 11I

An electron microscopic study of fracture surfaces and microtomed sections of a cured epoxy resin based on the difunctional Bisphenol-A type resin cured with different amounts of metaphenylene diamine is presented. Heterogeneities in the 5-100 nm range are seen to be present and have relatively higher crosslink density compared to the surrounding matrix. It is observed that the fracture path is around the heterogeneity and not through it. The size of the heterogeneity is a function of the curing agent concentration and also of the cure cycle. The stoichiometric sample, which has the highest crosslink density and the highest glass transition temperature, has the smallest heterogeneities. On either side of stoichiometry, the heterogeneity size increases. The samples subjected to a more severe postcuring cycle have much larger heterogeneities. The possible physical basis for these differences is discussed. GRA

N87-24562# Allied Bendix Corp., Kansas City, Mo.

CERAMIC CAPACITORS FOR USE IN FILTER CONNECTORS

R. R. Honig Feb. 1987 19 p Presented at the Electronic Components Conference, Boston, Mass., 11 May 1987

(Contract DE-AC04-76DP-00613)

(DE87-006656; BDX-613-3668R; CONF-870580-1) Avail: NTIS HC A02/MF A01

This paper describes the developing and qualifying of a filter connector. Since this filter connector used only capacitors rather than ferrites and capacitors, the typical characteristics of capacitors when used in a filter connector can be observed. Topics covered in this paper include connector construction, development results, and qualification data for both tubular capacitor and planar capacitor array designs. This paper will aid users and manufacturers of filter connectors in the selection of the appropriate capacitor type for use in their filter connectors and inform capacitor manufacturers of the difficulties encountered in using these capacitors. DOE

N87-24563*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STABILITY OF BROMINE, IODINE MONOCHLORIDE, COPPER (II) CHLORIDE, AND NICKEL (II) CHLORIDE INTERCALATED PITCH-BASED GRAPHITE FIBERS

James R. Gaier, Melissa E. Slabe, and Nanette Shaffer (Intercal Co., Port Huron, Mich.) Jul. 1987 18 p Prepared for the 18th Biennial Conference on Carbon, Worcester, Mass., 19-24 Jul. 1987; sponsored by American Carbon Society

(NASA-TM-89904; E-3431; NAS 1.15:89904) Avail: NTIS HC A02/MF A01 CSCL 11G

Four different grades of pitch-based graphite fibers (Amoco P-55, P-75, P-100. and P-120) were intercalated with each of four different intercalates: bromine (Br2), iodine monochloride (ICl), copper (II) chloride (CuCl2), and nickel (II) chloride (NiCl2). The P-55 fibers did not react with Br2 or NiCl2, and the P-75 did not react with NiCl2. The stability of the electrical resistance of the intercalated fibers was monitored over long periods of time in ambient, high humidity (100 percent at 60 C), vacuum (10 to the -6 torr), and high temperature (up to 400 C) conditions. Fibers with lower graphitization form graphite intercalation compounds (GIC's) which are more stable than those with higher graphitization (i.e., P-55 (most stable) greater than P-75 greater than P-100 greater than P-120 (least stable). Br2 formed the most stable GIC's followed in order of decreasing stability by ICl, CuCl2, and NiCl2. While Br2 GIC's had the most stability, ICl had the advantages of forming GIC's with slightly greater reduction in resistance (by about 10%) than Br2, and the ability to intercalate P-55 fiber. Transition metal chlorides are susceptible to water vapor and high temperature. The stability of fibers in composites differs. Author

N87-24564* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FIRE AND HEAT RESISTANT LAMINATING RESINS BASED ON MALEIMIDO AND CITRACONIMIDO SUBSTITUTED 1-(CH173)(DIORGANO OXYPHOSPHONYL) METHYL(CH189) -2,4- AND -2,6- DIAMINOBENZENES Patent

John A. Mikroyannidis, inventor (to NASA) (National Academy of Sciences - National Research Council, Washington, D. C.) and Demetrius A. Kourtides, inventor (to NASA) 23 Jun. 1987 11 p Filed 10 Apr. 1986 Division of US-Patent-Appl-SN-641147, filed 16 Aug. 1984, which is a continuation-in-part of US-Patent-Appl-SN-522629, filed 12 Aug. 1983, abandoned

(NASA-Case-ARC-11533-3; US-Patent-4,675,379; US-Patent-Appl-SN-852467; US-Patent-Class-528-413) Avail: US Patent and Trademark Office CSCL 11B

A class of fire and heat resistant bisimide resins prepared by thermal polymerization of maleimido or citraconimido substituted 1-((dialkoxyphosphonyl) methyl)-2-4 and -2,6-diaminobenzenes are described. The polymer precursors are prepared by reacting 1-((diorganooxyphosphonyl) methyl)-2-4 and -2,6-diaminobenzenes with maleic anhydride or citraconic anhydride in a mole ratio 1:2. Chain extension of the monomers is achieved by reacting the mono-N-maleimido derivatives of 1-((diorganooxyphosphonyl) methyl)-2,4 and -2,6-diaminobenzenes with aryl tetracarboxylic dianhydrides, such as benzophenone tetracarbocylic dianhydride, or aryl diisocyanates, such as methylenebis (4-phenylisocyanate), in a mole ratio 2:1. The polymerization of the monomers is studied by differential scanning calorimetry (DSC) and the thermal stability of the polymers is ascertained by thermogravimetric analysis (TGA). Official Gazette of the U.S. Patent and Trademark Office

N87-24565*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TRIBOLOGICAL PROPERTIES OF COAL SLURRIES

Robert L. Fusaro and Dale L. Schrubens 1987 27 p Prepared for presentation at the Joint Tribology Conference, San Antonio, Tex., 5-8 Oct. 1987; cosponsored by American Society of Lubrication Engineers, and ASME

(NASA-TM-89930; E-3634; NAS 1.15:89930) Avail: NTIS HC A03/MF A01 CSCL 11G

A pin-on-disk tribometer was used to study the tribological properties of methyl alcohol-coal slurries. Friction coefficients, steel pin wear rates and wear surface morphological studies were conducted on AISI 440C HT and M-50 bearing steels which were slid dry and in solutions of methyl alcohol, methyl alcohol-fine coal particles, and methyl alcohol-fine coal particles-flocking additive. The latter was an oil derived from coal and originally intended to be added to the coal slurry to improve the sedimentation and rheology properties. The results of this study indicated that the addition of the flocking additive to the coal slurry markedly improved the tribological properties, especially wear. In addition, the type of steel was found to be very important in determining the type of wear that took place. Cracks and pits were found on the M-50 steel pin wear surfaces that slid in the coal slurries while 440C HT steel pins showed none. Author

N87-24566*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF ABRASIVE GRIT SIZE ON WEAR OF MANGANESE-ZINC FERRITE UNDER THREE-BODY ABRASION
Kazuhisa Miyoshi 1987 26 p Proposed for presentation at the 1987 Joint Tribology Conference, San Antonio, Tex., 5-8 Oct. 1987; sponsored by the American Society of Lubrication Engineers and ASME
(NASA-TM-89879; E-3559; NAS 1.15:89879) Avail: NTIS HC A03/MF A01 CSCL 11G

Wear experiments were conducted using replication electron microscopy and reflection electron diffraction to study abrasion and deformed layers produced in single-crystal Mn-Zn ferrites under three-body abrasion. The abrasion mechanism of Mn-Zn ferrite changes drastically with the size of abrasive grits. With 15-micron (1000-mesh) SiC grits, abrasion of Mn-Zn ferrite is due principally to brittle fracture; while with 4- and 2-micron (4000- and 6000-mesh) SiC grits, abrasion is due to plastic deformation and fracture. Both microcracking and plastic flow produce polycrystalline states on the wear surfaces of single-crystal Mn-Zn ferrites. Coefficient of wear, total thickness of the deformed layers, and surface roughness of the wear surfaces increase markedly with an increase in abrasive grit size. The total thicknesses of the deformed layers are 3 microns for the ferrite abraded by 15-micron SiC, 0.9 microns for the ferrite abraded by 4-micron SiC, and 0.8 microns for the ferrite abraded by 1-micron SiC. Author

N87-24567*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PREPARATION OF POLYSTYRENE MICROSPHERES FOR LASER VELOCIMETRY IN WIND TUNNELS
Cecil E. Nichols, Jr. Jun. 1987 11 p
(NASA-TM-89163; NAS 1.15:89163) Avail: NTIS HC A02/MF A01 CSCL 11B

Laser Velocimetry (L/V) had made great strides in replacing intrusive devices for wind tunnel flow measurements. The weakness of the L/V has not been the L/V itself, but proper size seeding particles having known drag characteristics. For many Langley Wind Tunnel applications commercial polystyrene latex microspheres suspended in ethanol, injected through a fluid nozzle provides excellent seeding but was not used due to the high cost. This paper provides the instructions, procedures, and formulations for producing polystyrene latex monodisperse microspheres of 0.6, 1.0, 1.7, 2.0, and 2.7 micron diameters. These are presently being used at Langley Research Center as L/V seeding particles. Author

N87-24568# Leybold-Heraeus G.m.b.H., Hanau/Main (West Germany).
INDUSTRIAL DEVELOPMENT OF MICROWAVE PLASMA POLYMERIZATION Final Report, May 1985
Michael Sellschopp Bonn, West Germany BMFT Dec. 1986 74 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-085; ISSN-0340-7608; ETN-87-99694) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 15

A plasma polymerization technology which can be used for industrial-type applications was developed. It employs a microwave low pressure plasma. A pilot plant for the coating of discrete and continuous materials was designed and built. Discrete substrates of dimensions up to 400mm x 600mm can be coated at high deposition rate and high throughput. An additional winding unit allows the treatment of polymer webs with a width of 25 cm and a length of several hundred m. The film properties depend on the kind of monomer as well as on the process parameters. The activation of polymer surfaces for the enhancement of adhesion is demonstrated. ESA

N87-24569# Construcciones Aeronauticas S.A., Madrid (Spain). Div. de Proyectos.
COMPARATIVE STUDY OF RUBBER BAND HOLDERS [ESTUDIO COMPARTIVO DE CORDONES DE GOMA]
O. Ruiz 10 Nov. 1986 4 p In SPANISH
(Informe-I-157/86; ETN-87-99847) Avail: NTIS HC A02/MF A01

Rubber bands were used to hold objects in a vaccum chamber. Corrosion behavior improvement is studied comparing the current carbon black filled bands with white and gray silicon rubber bands. After physical and chemical characterization, aging was tested using taladyne solution. White silicon rubber is found to be better. ESA

N87-24570# Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Adhesion Science.
A NONLINEAR CONSTITUTIVE BEHAVIOR FOR DIFFUSION IN POLYMERS Interim Report, 1-30 Jun. 1986
D. R. Lefebvre, T. C. Ward, D. A. Dillard, and H. F. Brinson 24 Feb. 1987 37 p
(Contract N00014-82-K-0185)
(AD-A179739; AD-F630743; CAS/ESM-87-1; VPI-E-87-2) Avail: NTIS HC A03/MF A01 CSCL 07C

Nonlinear diffusion is defined within the framework of Fick's laws where the diffusion coefficient, D, is a function of penetrant concentration, temperature and stress. It is also recognized that these same parameters are contained in a memory dependent free volume description of polymers. Combining the Stokes-Einstein equation for diffusion with a WLF shift function allows the Doolittle equation for free volume to be interpreted in terms of diffusion of penetrant. It is further shown that the history dependent diffusion law needs to be solved together with the usual stress-strain viscoelastic law at a material point in order to quantify the effect of diffusion on the stress field or vice-versa. GRA

N87-24571# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
THERMOSET HIGH-TEMPERATURE SYSTEMS BASED ON THE HOMOLYTIC POLYMERIZATION OF BENZOCYCLOBUTENE AROMATIC IMIDE MONOMERS AND OLIGOMERS Final Report, 1 Sep. 1984 - 30 Mar. 1986
Leon-Seng Tan and Fred E. Arnold Jun. 1986 69 p
(AD-A179775; AFWAL-TR-86-4090) Avail: NTIS HC A04/MF A01 CSCL 07C

A new series of bisbenzocyclobutene-terminated aromatic imide oligomers has synthesized from the condensation reaction of 4-aminobenzocyclobutene and the perspective dianhydride in refluxing acetic acid/toluene. The differential scanning calorimetric studies of the foregoing monomers indicated that polymerization exotherms began at 229-250 C and reached their maxima at 258-263 C. The cured samples (250-254 C; Nitrogen; 8 hrs) were surprisingly stable toward thermooxidative degradation; only 7- to 10- percent weight loss was observed after 200 hrs (in air) at 314 C (600 F). GRA

N87-24572# Akron Univ., Ohio. Inst. of Polymer Science.
NEW AND IMPROVED TESTS FOR ADHESION
A. N. Gent May 1987 16 p
(Contract N00014-85-K-0222)
(AD-A179955; TR-9) Avail: NTIS HC A02/MF A01 CSCL 20K

Three methods are discussed for measuring the work G sub a required to break a bond: Outwater's double-torsion test for long plates, bonded together; a pull-off test for an elastic strip adhering to a rigid surfaces; and a blister test for an adhering elastic layer. The pull-off force F or blow-off pressure P is given by: F4(or P4) is directly proportional to KG sub a cubed where K is the tensile stiffness of the detaching layer. This unusual dependence arises from the non-linear (cubic) relation between force or pressure and pull-off angle theta or blister height y. However, the products F theta and Py give direct measures of G sub a, independent of stiffness and the extent of detachment. GRA

N87-24573*# Massachusetts Inst. of Tech., Cambridge.
PROCESSING OF LASER FORMED SiC POWDER Final Report
J. S. Haggerty and H. K. Bowen Jun. 1987 80 p
(Grant NAG3-312)
(NASA-CR-179638; NAS 1.26:179638) Avail: NTIS HC A05/MF A01 CSCL 11B

Processing research was undertaken to demonstrate that superior SiC characteristics could be achieved through the use of ideal constituent powders and careful post-synthesis processing steps. Initial research developed the means to produce approximately 1000 A uniform diameter, nonagglomerated, spherical, high purity SiC powders. Accomplishing this goal required major revision of the particle formation and growth model from one based on classical nucleation and growth to one based on collision and coalescence of Si particles followed by their carburization. Dispersions based on pure organic solvents as well as steric stabilization were investigated. Test parts were made by the colloidal pressing technique; both liquid filtration and consolidation (rearrangement) stages were modeled. Green densities corresponding to a random close packed structure were achieved. After drying, parts were densified at temperatures ranging from 1800 to 2100 C. This research program accomplished all of its major objectives. Superior microstructures and properties were attained by using powders having ideal characteristics and special post-synthesis processing procedures. Author

N87-24574*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECTS OF SEQUENTIAL TREATMENT WITH FLUORINE AND BROMINE ON GRAPHITE FIBERS
Ching-cheh Hung, Mark Stahl, Carolyn Maciag, and Melissa Slabe Jul. 1987 15 p Presented at the 18th Biennial Conference on Carbon, Worcester, Mass., 19-24 Jul. 1987; sponsored by American Carbon Society Prepared in cooperation with Cleveland State Univ., Ohio
(NASA-TM-100106; E-3644; NAS 1.15:100106) Avail: NTIS HC A02/MF A01 CSCL 11G

Three pitch based graphite fibers with different degrees of graphitization and one polyacryonitrile (PAN) based carbon fiber from Amoco Corporation were treated with 1 atm, room temperature fluorine gas for 90 hrs. Fluorination resulted in higher electrical conductivity for all pitch fibers. Further bromination after ambient condition defluorination resulted in further increases in electrical defluorination conductivity for less graphitized, less structurally ordered pitch fibers (P-55) which contain about 3% fluorine by weight before bromination. This product can be stable in 200 C air, or 100% humidity at 60 C. Due to its low cost, this less graphitized fiber may be useful for industrial application, such as airfoil deicer materials. The same bromination process, however, resulted in conductivity decreases for fluorine rich, more graphitized, structurally oriented pitch fibers (P-100 and P-75). Such decreases in electrical conductivity were partially reversed by heating the fibers at 185 C in air. Differential scanning calorimetric (DSC) data indicated that the more graphitized fibers (P-100) contained BrF3, whereas the less graphitized fibers (P-55) did not. Author

N87-24575*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
POLYIMIDES CONTAINING CARBONYL AND ETHER CONNECTING GROUPS Patent Application
Paul M. Hergenrother, inventor (to NASA) and Stephen J. Havens, inventor (to NASA) (PRC Kentron, Inc., Hampton, Va.) 5 Feb. 1987 18 p
(NASA-Case-LAR-13633-1; NAS 1.71:LAR-13633-1; US-Patent-Appl-SN-011693) Avail: NTIS HC A02/MF A01 CSCL 11B

New polyimides have been prepared from the reaction of aromatic dianhydrides with novel aromatic diamines containing carbonyl and ether connecting groups between the aromatic rings. Several of these polyimides were shown to be semi-crystalline polyimides as evidenced by wide angle x-ray diffraction and differential scanning calorimetry. Most of the semi-crystalline polyimides form tough solvent resistant films with high tensile properties. One of these materials exhibits very high fracture toughness and can be thermally processed. NASA

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N87-24576# Naval Weapons Support Center, Crane, Ind. Applied Sciences Dept.
USA PYROTECHNICS OVERVIEW Final Report
Bernard E. Douda 23 Feb. 1987 17 p
(AD-A179966; NWSC/CR/RDTR-339) Avail: NTIS HC A02/MF A01 CSCL 19A

This paper addresses main pyrotechnic efforts relating to infrared decoys and smoke/obscurants for protection of aircraft, ships and tanks from threat devices and agencies which have substantial pyrotechnics interest. This paper was presented at the Pyrotekinkdagen Symposium 16 October 1986, at the University of Lund, Sweden. GRA

N87-24577*# Pratt and Whitney Aircraft, East Hartford, Conn.
ANTIMISTING KEROSENE JT3 ENGINE FUEL SYSTEM INTEGRATION STUDY Final Report
A. Fiorentino Washington NASA Jan. 1987 48 p
(Contracts NAS3-24217; NAS3-24353; DTFA03-81-A-00154)
(NASA-CR-4033; NAS 1.26:4033) Avail: NTIS HC A03/MF A01 CSCL 21D

An analytical study and laboratory tests were conducted to assist NASA in determining the safety and mission suitability of the modified fuel system and flight tests for the Full-Scale Transport Controlled Impact Demonstration (CID) program. This twelve-month study reviewed and analyzed both the use of antimisting kerosene (AMK) fuel and the incorporation of a fuel degrader on the operational and performance characteristics of the engines tested. Potential deficiencies and/or failures were identified and approaches to accommodate these deficiencies were recommended to NASA Ames -Dryden Flight Research Facility. The result of flow characterization tests on degraded AMK fuel samples indicated levels of degradation satisfactory for the planned missions of the B-720 aircraft. The operability and performance with the AMK in a ground test engine and in the aircraft engines during the test flights were comparable to those with unmodified Jet A. For the final CID test, the JT-3C-7 engines performed satisfactorily while operating on AMK right up to impact. Author

N87-24578*# General Electric Co., Cincinnati, Ohio.
AVIATION FUEL PROPERTY EFFECTS ON ALTITUDE RELIGHT Final Report, Jan. 1984 - Jun. 1986
K. Venkataramani May 1987 67 p
(Contract NAS3-24215)
(NASA-CR-179582; NAS 1.26:179582; R87AEB111) Avail: NTIS HC A01/MF A01 CSCL 21D

The major objective of this experimental program was to investigate the effects of fuel property variation on altitude relight characteristics. Four fuels with widely varying volatility properties (JP-4, Jet A, a blend of Jet A and 2040 Solvent, and Diesel 2)

were tested in a five-swirl-cup-sector combustor at inlet temperatures and flows representative of windmilling conditions of turbofan engines. The effects of fuel physical properties on atomization were eliminated by using four sets of pressure-atomizing nozzles designed to give the same spray Sauter mean diameter (50 + or - 10 micron) for each fuel at the same design fuel flow. A second series of tests was run with a set of air-blast nozzles. With comparable atomization levels, fuel volatility assumes only a secondary role for first-swirl-cup lightoff and complete blowout. Full propagation first-cup blowout were independent of fuel volatility and depended only on the combustor operating conditions. Author

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

N87-24579*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

GRAVITATIONAL MACROSEGREGATION IN BINARY Pb-Sn ALLOY INGOTS

V. Laxmanan, A. Studer, L. Wang, J. F. Wallace (Case Western Reserve Univ., Cleveland, Ohio.), and E. A. Winsa 1986 36 p Presented at the Low Gravity Science Seminar Series, Boulder, Colo, 17 Feb. 1986; sponsored by Colorado Univ.

(NASA-TM-89885; E-3570; NAS 1.15:89885) Avail: NTIS HC A03/MF A01 CSCL 22A

A space shuttle experiment employing the General Purpose (Rocket) Furnace (GPF) in its isothermal mode of operation is manifested on MSL-3, circa 1989. The central aim of this experiment is to investigate the effect of reduced gravity levels on the segregation behavior in a slowly, and isothermally, cooled sample of a binary Pb-15 wt% Sn alloy. This experiment should be able to simulate, in a small laboratory sample, some aspects of the segragation phenomena occurring in large industrial ingots. Ground-based experiments conducted in the single-cavity simulator of the GPF, in support of the microgravity experiment are described in detail. The results of the MSFC experiments are compared with other related experiments conducted at Case Western Reserve University (CWRS), wherein the isothermal constraints were relaxed. The isothermally processed samples indicate a small and gradual increase in fraction eutectic, and a corresponding increase in tin content, from the bottom to the top of the ingot. The radial variations are minimal near the ingot bottom, but there are large radial variations in the top half. In the CWRU experiments, more severe segregations, including segregation defects known as freckles. Follow up experiments employing the GPF without the isothermal constraints, or other suitably modified space shuttle hardware are suggested. Author

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N87-24580# Science Applications International Corp., McLean, Va.

THE IMPACT OF METRICATION ON LIFE CYCLE COSTS OF THE LHX WEAPON SYSTEM Technical Report, Aug. 1986 - Feb. 1987

Robert P. Hunt, Bruce B. Halstead, Lisa Olshan, and Len P. Cheshire, Jr. 27 Feb. 1987 84 p

(Contract DAAK70-84-D-0053)

(AD-A178415; SAIC-87/1569) Avail: NTIS HC A05/MF A01 CSCL 05C

The aerospace industry and Army logisticians have expressed doubt that the Army fully understands the impact of metrication on the Life Cycle Cost of the LHX (Light Helicopter System) weapon system. This report provides Army decision-makers an analysis upon which to make decisions regarding metrication of the LHX and future materiel developments. Using cost and economic analysis techniques within the general scope of operations research/system it analyzes and compares LHX program implementation alternatives and provides a methodology to support management decisions relative to the acquisition process. GRA

N87-24581# Societe Europeenne de Propulsion, Vernon (France). Dept. Espace.

FREON PUMP PACKAGE Final Report

A. Duwelz Paris, France ESA 30 Apr. 1986 173 p

(Contract ESTEC-5725/83-NL-PB)

(SEP-TS/MP-80568/85; ESA-CR(P)-2312; ETN-87-99867) Avail: NTIS HC A08/MF A01

A preliminary design study of a freon pump package (FPP) was undertaken to determine the feasibility of a very silent pump package and to get the main technical characteristics and features of this FPP. A layout, a mass breakdown, a system block diagram, together with the design objectives and the design philosophy to achieve a very low level of noise are shown. The flow rate regulation modes which are incorporated in the FPP design are detailed. The tradeoffs performed to select the main components of the pump unit are presented. The electric motor, bearing, and pump candidates are reviewed and the final choice is given. A preliminary design of the pump unit is given, with the estimated performance. A development plan for the FPP and the pump unit is proposed, with a test plan based on the preliminary technical specifications. ESA

N87-24582# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

HOW TO PERFORM STATISTICAL TOLERANCE ANALYSIS

N. D. Cox 1987 5 p Presented at the 41st Annual Quality Conference, Minneapolis, Minn., 4 May 1987

(Contract DE-AC07-76ID-01570)

(DE87-001442; EGG-M-32186; CONF-870544-1) Avail: NTIS HC A02/MF A01

This exposition deals with techniques of statistical tolerance analysis. The intent of the methodology is to allow the engineer to evaluate the effect of manufacturing tolerances and uncertainties in functional parameters on the performance or dimensions of a manufactured product. It provides information on the probability distribution of the output or dimension so that the analyst can make decisions on the quality of the product prior to actual manufacture. The technique provides a general tool which can be used in the analysis of systems of a general nature. DOE

N87-24583# Hanford Engineering Development Lab., Richland, Wash.

ELECTROSPARK DEPOSITION COATINGS

W. F. Sheely 19 Nov. 1986 6 p

(Contract DE-AC06-76FF-02170)

(DE87-009530; HEDL-SA-3637(VT)) Avail: NTIS HC A02/MF A01

Hard surfacing for wear resistant and low-friction coatings has been improved by means of advances in the computer controls in electronic circuitry of the electrospark deposition (ESD) process. coatings of nearly any electrically conductive metal alloy or cermet can be deposited on conductive materials. Thickness is usually two mils or less, but can be as high as 10 mils. ESD coatings can quadrupole cutting tool life. DOE

N87-24584# Leybold-Heraeus G.m.b.H., Hanau/Main (West Germany). Abteillung VT 5.

HELIUM LIQUEFACTION USING CRYOREFRIGERATORS Final Report, Feb. 1984

Hans-Joachim Forth Bonn, West Germany BMFT Dec. 1986 53 p In GERMAN; ENGLISH summary Sponsored by BMFT

(BMFT-FB-T-86-084; ISSN-0340-7608; ETN-87-99693) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 11

A two-stage Gifford-McMahon refrigerator with a Joule-Thomson (J-T) stage connected in series, was extended to a small helium

liquefier. The plant can operate automatically. Helium is liquefied within the J-T cycle, directly after the J-T valve, into a 3l tank. This liquid He is used for the indirect cooling of an externally accessible sample chamber, either by using helium contact gas, or by means of liquid He condensed from an external helium gas source. The second design is meant for laboratory applications. The liquid helium tank is not incorporated in the J-T cycle, but thermally connected to the J-T stage of the refrigerator. The He gas from an external source is then condensed into the 2l tank. The liquid helium is accessible via a top-loading sample tube. The refrigerating capacity of both devices is 2W at 4.5K. The cleaning procedures for the He gas to be condensed into the tanks, and the production of temperatures below 4.2K in the He bath are described. ESA

N87-24585*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A NEW APPROACH TO STATE ESTIMATION IN DETERMINISTIC DIGITAL CONTROL SYSTEMS
Michael E. Polites Jul. 1987 16 p
(NASA-TP-2745; NAS 1.60:2745) Avail: NTIS HC A02/MF A01 CSCL 09B

The paper presents a new approach to state estimation in deterministic digital control systems. The scheme is based on sampling the output of the plant at a high rate and prefiltering the discrete measurements in a multi-input/multi-output moving average (MA) process. The coefficient matrices in the MA prefilter are selected so the estimated state equals the true state. An example is presented which illustrates the procedure to follow to completely design the estimator. Author

N87-24586# Rice Univ., Houston, Tex.
LEAKING UNDERGROUND STORAGE TANKS: REMEDIATION WITH EMPHASIS ON IN SITU BIORESTORATION Final Report, May - Oct. 1986
J. M. Thomas, M. D. Lee, P. B. Bedient, R. C. Borden, and L. W. Canter Jan. 1987 155 p Sponsored in part by Robert S. Kerr Environmental Research Lab.
(PB87-168084; EPA/600/2-87/008) Avail: NTIS HC A08/MF A01 CSCL 13B

The current literature indicates that in situ biorestoration has great potential for remediation of aquifers contaminated by leaking underground storage tanks. In situ aquifer restoration involves the enhancement of the indigenous microflora to degrade subsurface pollutants. The presence of indigenous microorganisms that can degrade subsurface contaminants has been demonstrated. Enriching for microorganisms with special metabolic capabilities has been demonstrated in the laboratory and may be promising for in situ biorestoration schemes. Mathematical models of biorestoration have been developed to stimulate progress of the cleanup and provide information on the kinetics of the process. This report emphasizes the state-of-the-art knowledge of in situ biorestoration techniques available for remediation of contaminated ground water. GRA

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N87-24587# Naval Postgraduate School, Monterey, Calif.
MULTIFREQUENCY UNIPOLE ANTENNA DESIGNS USING THE NUMERICAL ELECTROMAGNETICS CODE M.S. Thesis
Nicolaos Paleologos Dec. 1986 74 p
(AD-A177904; AD-E950921; NPS62-87-005) Avail: NTIS HC A04/MF A01 CSCL 17B

The folded unipole antenna has recently appeared as a commercially available alternative to conventional insulated-base monopoles in standard broadcast applications. A folded unipole antenna has significant advantages over both series fed vertical and top-loaded antennas. This thesis investigates using a computer numerical model to obtain the input impedance of a 72 meter folded unipole antenna, with three fold wires. The design of a multi-frequency folded unipole antenna is demonstrated for 1.380 and 1.530 MHz. Also presented are designs for 60 deg., 90 deg., 135 deg., 180 deg., 225 deg. folded unipole antennas for a frequency of 1 MHz, with an input resistance of 50 ohms. Finally, designs are shown for 90 deg. monopole and 90 deg. unipole antennas at 1 MHz. GRA

N87-24588# Massachusetts Univ., Amherst.
WORKSHOP ON MICROWAVE SCATTERING AND EMISSION FROM THE EARTH'S SURFACE HELD IN WASHINGTON, D.C. ON 11-12 APRIL 1985 Final Report
Keith R. Carver and Roger Lang Oct. 1986 82 p Workshop held in Washington, D.C., 11-12 Apr. 1985 Prepared in cooperation with George Washington Univ., Washington, D.C.
(AD-A178269) Avail: NTIS HC A05/MF A01 CSCL 20N

A workshop on microwave scattering and emission from the Earth's surface produced the following reports: Overview of Dense Medium Modeling; Radiative Transfer Equations Modified for Dense; Laboratory Experiments and Modeling of Multiple Scattering in Dense Discrete Scatters; Transport Theory for Random Waves through Pair-Correlated Discrete Scatters; Microwave Observations of Soil and Snow; Overview of Discrete Media Modeling; Scattering Amplitude Models for Remote Sensing; Remote Sensing in Light of Inverse Scattering Theory; Amplitude Distribution of Composite Terrain Radar Clutter; Overview of Rough Surface Modeling; Topics in Sea Scatter and Rain/Sea Scatter Interactions; A Phase Perturbation Method for Randomly Rough Surfaces; Experimental Observations of Microwave Scattering and Emission from Sea and Glacial Ice; A Numerical Study of the Region of Validity of the Kirchhoff and Small Perturbation Theories in Rough Surface Scattering; C Band Scatterometer; and Multi polarization Synthetic Aperture Radar: Calibration and Early Results. GRA

N87-24589# Naval Ocean Systems Center, San Diego, Calif.
AN ALTITUDE-ERROR DISPLAY FOR HEIGHT-FINDER RADAR Final Report, Sep. 1985 - Apr. 1986
A. E. Barrios Jan. 1987 50 p
(AD-A178382; NOSC/TR-1152) Avail: NTIS HC A03/MF A01 CSCL 17I

Strong ducting conditions occur over many ocean areas. These conditions affect height-finder radars (such as the SPS-48) in giving accurate target positions. Most height-finder radars calculate altitude based on a standard atmosphere. When ducting conditions are present, large errors can occur between the calculated and the true target height, depending on the transmitter height and the target range. In many cases, these errors are greater than 50 percent. A height-finder radar altitude-error display has been developed to show the amount of error present. The display looks like an ordinary ray-trace display, except the color of the rays are dependent on the height difference, as compared to and standard atmosphere for the same elevation angle and range. GRA

N87-24590*# National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
A SYNCHRONOUS DATA ANALYZER FOR THE MINIMUM DELAY DATA FORMAT (MDDF) AND LAUNCH TRAJECTORY ACQUISITION SYSTEM (LTAS)
Andrew J. Green Jul. 1987 10 p
(NASA-TP-2743; Rept-822.1; NAS 1.60:2743) Avail: NTIS HC A02/MF A01 CSCL 17B

The Synchronous Data Analyzer gives its user an independent source for checking the validity of raw MDDF and LTAS data. Its ability to produce real-time displays comprised of decoded parameters as well as its ability to capture several frames for non-real-time display makes it a valuable tool for monitoring and troubleshooting applications involving these data formats. Its

composition of portable firmware and mostly commercial hardware makes it a low cost, easily fabricated product. Author

N87-24591*# Johns Hopkins Univ., Baltimore, Md. Dept. of Electrical and Computer Engineering.
OPTICAL COMMUNICATION WITH SEMICONDUCTOR LASER DIODES Interim Progress Report
F. Davidson 17 Jul. 1987 32 p
(Grant NAG5-356)
(NASA-CR-181078; NAS 1.26:181078) Avail: NTIS HC A03/MF A01 CSCL 17B

A 25 megabit/sec direct detection optical communication system that used Q=4 PPM signalling was constructed and its performance measured under laboratory conditions. The system used a single-mode AlGaAs laser diode transmitter and low noise silicon avalanche photodiode (APD) photodetector. Comparison of measured performance with the theoretical revealed that modeling the APD output as a Gaussian process under conditions of negligible background radiation and low (less than 10 to the -12 power A) APD bulk leakage currents leads to substantial underestimates of optimal APD gain to use and overestimates of system bit error probability. A procedure is given to numerically compute system performance which uses the more accurate Webb's Approximation of the exact Conradi distribution for the APD ouput signal that does not require excessive amounts of computer time (a few minutes of VAX 8600 CPU time per system operating point). Examples are given which illustrate the breakdown of the Gaussian approximation in assessing system performance. This system achieved a bit error probability of 10 to the -6 power at a received signal energy corresponding to an average of 60 absorbed photons/bit and optimal APD gain of 700. Author

N87-24592*# Signatron, Inc., Lexington, Mass.
A 30/20 GHz FSS FEASIBILITY STUDY Final Report
12 Feb. 1987 296 p Prepared for JPL
(Contract JPL-957641)
(NASA-CR-181088; JPL-9950-1305; NAS 1.26:181088; A562-08)
Avail: NTIS HC A13/MF A01 CSCL 17B

The near term feasibility of direct-to-subscriber services were determined using the 30/20 GHz Fixed Satellite Service (FSS) frequency bands. Those technologies which need to be further developed before such a system can be implemented, were identified. To determine this feasibility, dozens of potential applications were examined for their near-term viability, and the subscriber base of three promising applications were estimated. The system requirements, terminal design, and satellite architecture were all investigated to determine whether a 30/20 GHz FSS system is technically and economically feasible by mid-1990s. It was concluded that such a system is feasible, although maturation of some technologies is needed. This system would likely consist of one or two multibeam satellites serving hub/spoke networks of simple user terminals and more complex, mutli-channel terminals of the service providers. Rain compensation would be accomplished non-adaptively through the use of coding, nonuniform satellite TWT power that is a function of a beam's anticipated downlink fading, and signal regeneration of traffic to the wettest climate regions. It was estimated that a potential market of almost two million users could exist in in the mid-1990s time frame for home banking and financial services via Ka-band satellites. Author

N87-24593# Sandia National Labs., Albuquerque, N. Mex.
MEASURED RADAR RETURN AT THE NEAR VERTICAL FROM FORESTED TERRAINS
D. A. Jelinek May 1987 57 p
(Contract DE-AC04-76DP-00789)
(DE87-009384; SAND-86-2618) Avail: NTIS HC A04/MF A01

This report presents the results of measurements that were made of the radar return from forested terrains. Measurements were taken while making straight and level passes with a helicopter over nearly pure stands of dense conifer and deciduous forests which were located on very flat terrain. The measurements were made using a 20-nanosecond pulse width, x-band radar and 16-degree-beamwidth antennas pointed straight down. Results are presented in terms of the average return power density at the receiving antenna as a function of round-trip delay for each forest for altitudes above the forest floor ranging from 100 to 1000 feet. DOE

N87-24594 Paris-Sud Univ., Orsay (France).
PHASE LOCKED LOOPS FOR BURST TRANSMISSION Ph.D. Thesis [BOUCLES A VERROUILLAGE DE PHASE POUR LES TRANSMISSIONS PAR SALVES]
Moussa Louafi 1986 201 p In FRENCH; ENGLISH summary
(ETN-87-99565) Avail: Issuing Activity

The operation properties of phase locked loops (PLL) in the burst mode of operation are studied including first order PLL, second order PLL with a passive lag-lead filter, second order PLL with an active filter, first order PLL with a zero order hold, and order PLL with a passive lag-lead filter and a zero order hold. The behavior is analyzed for incoming signals affected by step changes in phase and frequency. The performance in the presence of additive Gaussiar. noise is also studied. The practical use of the results is discussed. ESA

N87-24595 Paris-Sud Univ., Orsay (France).
CHARACTERIZATION OF A RADIO CHANNEL IN MULTIPATH PROPAGATION PERIODS Ph.D. Thesis [CARACTERISATION D'UN CANAL HERTZIEN EN PERIODE DE TRAJETS MULTIPLES]
Michel Sylvain 1986 138 p Partly in FRENCH and ENGLISH; ENGLISH summary
(ETN-87-99571) Avail: Issuing Activity

Microwave links during multipath propagation are studied. The method is based on a mathematical model of the transfer function of the propagation channel on a bandwidth 50 MHz wide. It is shown that three models can be used. Their relationships with the physical model are established. The joint probability laws of the model parameters are studied on three different links. A knowledge of the numerical values allows to predict the quality of the link. The estimation of the coefficients from simple propagation data is discussed. ESA

N87-24596# Naval Research Lab., Washington, D. C.
INTELLIGIBILITY OF ICAO (INTERNATIONAL CIVIL AVIATION ORGANIZATION) SPELLING ALPHABET WORDS AND DIGITS USING SEVERELY DEGRADED SPEECH COMMUNICATION SYSTEMS. PART 1: NARROWBAND DIGITAL SPEECH Interim Report, Oct. 1985 - Sep. 1986
Astrid Schmidt-Nielsen 31 Mar. 1987 24 p
(AD-A179849; NRL-9035-Pt-1) Avail: NTIS HC A02/MF A01 CSCL 17E

The Diagnostic Rhyme Test (DRT) is widely used to evaluate digital voice systems. Would-be users often have no reference frame of interpreting DRT scores in terms of performance measures that they can understand, e.g., how many operational words are correctly understood. This research was aimed at providing a better understanding of the effects of very poor quality speech on human communication performance. It is especially important to determine how successful communications are likely to be when the speech quality is severely degraded. This report compares the recognition of ICAO spelling alphabet words (ALFA, BRAVO, CHARLIE, etc) with DRT scores for the same conditions. Confusions among the spelling alphabet words are also given. Two types of speech degradation were selected for investigation: narrowband digital speech (the DoD standard linear predictive coding algorithm operating at 2400 bits/s) with varying bit-error rates and analog jamming. The report will be in two parts. Part 1 covers the narrowband digital speech research, and Part 2 will cover the analog speech research. GRA

N87-24597# California Univ., Los Angeles. Dept. of Electrical Engineering.
OPTIMAL LIST METRIC RECEIVERS FOR SPREAD SPECTRUM MULTIPLE ACCESS RADIO NETWORKS Final Report
Jim K. Omura Oct. 1986 11 p
(Contract N00014-84-K-0243)
(AD-A179852) Avail: NTIS HC A02/MF A01 CSCL 17E

(Contract N00014-84-K-0243)
(AD-A179852) Avail: NTIS HC A02/MF A01 CSCL 17E

Research conducted under this grant studied the performance of various receivers for Frequency Hopped M-ary Frequency Shift Keyed Signals in jamming and multiple access environments. This work was divided into two parts: 1. Analysis of conventional List Metric Receivers; 2. Analysis of Optimal Multiple Access Receivers; Conventional list metric receivers were examined for both jamming and multiple access channels by Mark Alan Creighton as part of his Ph.D dissertation research. This work has been completed and Mark Creighton has obtained his Ph.D based on this work. The second part of this grant research has been conducted by Quang Vo as his Ph.D dissertation research. This part examined the performance of optimal and suboptimal multiple access receivers. The result of this work is a very practical multiple receiver design that performs almost as well as an ideal optimal receiver for M-ary FSK signals. Quan Vo has completed this research work and is now writing his dissertation. GRA

N87-24598# Virginia Polytechnic Inst. and State Univ., Blacksburg.
WAVE STATISTICS IN RANDOM MEDIA: A WAVE-KINETIC NUMERICAL APPROACH Final Report, Sep. 1985 - Jan. 1987
David A. DeWolf Feb. 1987 6 p
(Contract DAAG29-85-K-0232)
(AD-A179950; ARO-22756.4-GS) Avail: NTIS HC A02/MF A01 CSCL 20F

The determination of the irradiance distribution of a wave after propagation through a medium of random fluctuations of refractive index at scales large compared to a wavelength has been an intractable problem. It has been possible to calculate moments of the distribution asymptotically or numerically. In this report the author tries to simulate on computer the actual instantaneous random medium, and the propagation of waves through it by means of a phase-space function, the Wigner distribution function which carries information beyond ray crossings and caustics. The method uses an efficient algorithm for propagation of this WDF by discretizing it into Gaussians which are separately propagated. Two canonical problems have been treated by the wave-kinetical method: free-space propagation and broadening of a collimated laser beam, and scattering of a plane wave by one Gaussian fluctuation of the refractive index. The results agree with what is expected. Simulation of a strong phase screen has been investigated, but the work is unfinished. The author's random-eddy model is still too unwieldy (in size) for the extended medium. Quasi-random models are currently being investigated. GRA

N87-24599# Ohio State Univ., Columbus. Electroscience Lab.
RADAR TARGET IDENTIFICATION TECHNIQUES APPLIED TO A POLARIZATION DIVERSE AIRCRAFT DATA BASE
Alex J. Kamis, E. K. Walton, and F. D. Garber Mar. 1987 145 p
(Contract N00014-85-K-0321)
(AD-A180044; ESL-717220-2) Avail: NTIS HC A07/MF A01 CSCL 17I

The report investigates the performance of several types of multi-frequency radar systems employing a data base of measured monostatic radar signatures as descriptors for Radar Target Identification (RTI). The approach, a Monte-Carlo computer simulation, enables the evaluation of radar systems exploiting various aspects of RTI techniques. These aspects, examined by misclassification percentage curves, are: the number of interrogation frequencies, operating bandwidths, classification algorithm types, larger target aspect zones, and target descriptors called feature vectors. The data base of radar signatures was obtained at The Ohio State University ElectroScience Laboratory Compact Range facility, and consisted of scale model monostatic calibrated radar measurements from five commercial aircraft. It is shown that the fully-coherent radar feature vectors HH, VV, RR, LL, and RL perform very effectively for target identification with signal to noise ratios of O dB. It is also shown that the low-frequency sector of the data base provides good classification performance versus noise power, and that the number of frequencies within a given bandwidth is optimized by Shannon's sampling theorem. GRA

N87-24600*# Illinois Univ., Urbana-Champaign. Dept. of Electrical and Computer Engineering.
PHASE ERROR STATISTICS OF A PHASE-LOCKED LOOP SYNCHRONIZED DIRECT DETECTION OPTICAL PPM COMMUNICATION SYSTEM Technical Report, May 1987
Suresh Natarajan and C. S. Gardner May 1987 78 p
(Grant NsG5-049)
(NASA-CR-180380; NAS 1.26:180380; UILU-ENG-87-2549; EOSL-87-003) Avail: NTIS HC A05/MF A01 CSCL 17B

Receiver timing synchronization of an optical Pulse-Position Modulation (PPM) communication system can be achieved using a phased-locked loop (PLL), provided the photodetector output is suitably processed. The magnitude of the PLL phase error is a good indicator of the timing error at the receiver decoder. The statistics of the phase error are investigated while varying several key system parameters such as PPM order, signal and background strengths, and PPL bandwidth. A practical optical communication system utilizing a laser diode transmitter and an avalanche photodiode in the receiver is described, and the sampled phase error data are presented. A linear regression analysis is applied to the data to obtain estimates of the relational constants involving the phase error variance and incident signal power. Author

N87-24601# National Telecommunications and Information Administration, Boulder, Colo. Inst. for Telecommunication Sciences.
AUTOMATED PERFORMANCE ANALYSIS MODEL FOR GROUND-WAVE COMMUNICATION SYSTEMS
N. DeMinco Dec. 1986 112 p Sponsored in part by Army Information Systems Engineering Support Activity
(PB87-164778; NTIA/86-209) Avail: NTIS HC A06/MF A01 CSCL 17B

An automated analysis model is presented for the prediction of system performance of communications circuits that use the ground wave as the primary mode of propagation. The computer program Ground Wave Automated Performance Analysis (GWAPA) is a user-friendly program that can predict propagation loss, electric field strength, received power, noise, received signal-to-noise power ratio, and antenna factors over lossy Earth. The smooth-Earth and irregular-Earth propagation loss prediction methods can be used over either homogeneous or mixed paths. A special antenna algorithm is integrated into the computer program for rapid prediction of antenna performance as a function of antenna geometry, ground constants, frequency, and azimuthal direction for a variety of antennas. A description of the computer program GWAPA, a discussion of its capabilities , instructions for its use, and illustrative sample calculations are included in the report. GRA

N87-24602# National Telecommunications and Information Administration, Boulder, Colo. Inst. for Telecommunication Sciences.
UPDATED NOISE MODEL FOR USE IN IONCAP (IONOSPHERIC COMMUNICATION ANALYSIS AND PREDICTION PROGRAM)
A. D. Spaulding and F. G. Stewart Jan. 1987 68 p
(PB87-165007; NTIA/87-212) Avail: NTIS HC A04/MF A01 CSCL 17B

The report presents an updated and improved model designed for use in the high frequency propagation prediction program, IONCAP (Ionospheric Communication Analysis and Prediction Program). The model has, however, much more general applicability, since the frequency range 10 kHz to 30 MHz is covered. This report gives the history, as near as can be determined, of the existing noise routines and then develops the updated model based on current information. The three noise sources -- atmospheric, man-made, and galactic are treated and a more appropriate means of combining these three sources is developed. Examples of the use of the improved model in IONCAP

are included and comparisons made with the existing model.
GRA

N87-24603# General Accounting Office, Washington, D. C. National Security and International Affairs Div.
RADIO FREQUENCIES: EARLIER COORDINATION COULD IMPROVE SYSTEM USE AND SAVE COSTS
Feb. 1987 41 p
(PB87-157988; GAO/NSIAD-87-42; B-224129) Avail: NTIS HC A03/MF A01 CSCL 17B

The report reviews Department of Defense (DOD) efforts to coordinate the use of radio frequencies with European nations for command, control, and communication systems. It reports that delays and unnecessary cost resulted when DOD did not coordinate with host nations early in the development of communication systems to insure that the frequencies selected would be approved. In a separate and broader review of communications in the Pacific theater, a similar situation was found. GRA

N87-24604*# Texas A&M Univ., College Station. Dept. of Electrical Engineering.
TWO HYBRID ARQ ERROR CONTROL SCHEMES FOR NEAR EARTH SATELLITE COMMUNICATIONS
Shu Lin and Tadao Kasami (Osaka Univ., Toyonaka, Japan) [1986] 15 p
(Grant NAG5-778)
(NASA-CR-181126; NAS 1.26:181126) Avail: NTIS HC A02/MF A01 CSCL 17B

Two hybrid automatic repeat request (ARQ) error control schemes are proposed for NASA near earth satellite communications. Both schemes are adaptive in nature, and employ cascaded codes to achieve both high reliability and throughput efficiency for high data rate file transfer. Author

N87-24605*# Ohio State Univ., Columbus. ElectroScience Lab.
ENGINEERING CALCULATIONS FOR COMMUNICATIONS SATELLITE SYSTEMS PLANNING Interim Report
Charles H. Reilly, Eric K. Walton, and Paul Kohnhorst May 1987 39 p
(Grant NAG3-159)
(NASA-CR-181112; NAS 1.26:181112; Rept-718688-3) Avail: NTIS HC A03/MF A01 CSCL 17B

A procedure is described that was used to calculate minimum required satellite separations based on total link carrier to interference requirements. Also summarized are recent results with a switching algorithm for satellite synthesis problems. Analytic solution value bounds for two of the satellite synthesis models studied are described. Preliminary results from an empirical study of alternate mixed integer programming models for satellite synthesis are presented. Research plans for the near future are discussed. Author

N87-24508*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ANTENNA TECHNOLOGY SHUTTLE EXPERIMENT (ATSE)
R. E. Freeland, E. Mettler, L. J. Miller, Y. Rahmet-Samii, and W. J. Weber, III *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 779-807 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 20N

N87-24610# Joint Publications Research Service, Arlington, Va.
ROUNDING NOISE IN M-STAGE RECURSIVE DIGITAL FILTER Abstract Only
V. A. Geranin, L. I. Kotlyar, and P. A. Markelov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 1 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR) no. 7, Jul. 1986 p 10-15 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24611# Joint Publications Research Service, Arlington, Va.
ALGORITHM OF SPACE PROCESSING OF SIGNALS AND INTERFERENCE FOR ELECTROMAGNETIC COMPATIBILITY Abstract Only
A. P. Rodimov, V. V. Nikitchenko, and L. M. Konovalov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 2 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 54-56 Original language document was announced in IAA as A87-15567 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24612# Joint Publications Research Service, Arlington, Va.
OPTIMIZATION OF SPACE-TIME PROCESSING ALGORITHMS FOR RADIO SIGNALS Abstract Only
A. S. Bogachev *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 3 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 4, Apr. 1986 p 3-7 Original language document was announced in IAA as A86-39681 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24615# Joint Publications Research Service, Arlington, Va.
SIGNAL PROCESSING IN MULTIPOSITIONAL RADAR SYSTEMS Abstract Only
V. M. Petrov and T. G. Vyatkina *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 8 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 46-49 Original language document was announced in IAA as A87-15564 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24617# Joint Publications Research Service, Arlington, Va.
RECTANGULAR WAVEGUIDE H10 MODE DIFFRACTION IN ARRAY OF CIRCULAR INDUCTIVE RODS Abstract Only
A. M. Model and A. Yu. Savitskiy *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 54 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 4, Aug. 1986 p 13-18 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

N87-24755# Marconi Co. Ltd., Great Baddow (England).
THE EFFECT OF RECEIVER AMPLIFIER NON-LINEARITY ON ERS-1 SYNTHETIC APERTURE RADAR IMAGERY
J. J. W. Wilson *In* ESA Proceedings of the International Symposium of Progress in Imaging Sensors Nov. 1986 p 149-155 Sponsored by ESA (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24778# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
X-SAR: A SHUTTLE-BORNE X-BAND SYNTHETIC APERTURE RADAR
Wolfgang Gilg and David Miller *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 335-339 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24803# Marconi Co. Ltd., Chelmsford (England).
MOTION COMPENSATION AND GEOMETRIC DISTORTION IN AIRBORNE SAR IMAGERY
D. Blacknell, I. A. Ward, and A. Freeman *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 539-548 Sponsored by the Royal Signals Research Establishment Procurement Ministry of Defence, United Kingdom (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-25090# Tokyo Astronomical Observatory (Japan).
A PHOTON COUNTING TV CAMERA FOR ASTRONOMICAL EDUCATION
Syuzo Isobe, G. Sasaki, N. Shinohara, and H. Agata *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An

Educational Challenge Nov. 1986 p 355-358 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

N87-24606# Naval Surface Weapons Center, Silver Spring, Md.
GENERAL PURPOSE MULTI-BUS COMPATIBLE RADAR INTERFACE CARD (RIC) Final Report, Dec. 1985 - Dec. 1986
John McCorkle 4 Dec. 1986 68 p
(AD-A178327; NSWC/TR-86-430) Avail: NTIS HC A04/MF A01 CSCL 17I

This paper reports on research aimed at demonstrating a militarized (small), low-cost, low-power, multi-bus compatible, interface card capable of connecting a low-cost commercial navigation radar system to a small computer. A demonstration circuit was constructed on a 5.5 x 8.5 inch 6-layer printed circuit board (PBC) with a standard multi-bus edge connector. Range, amplitude, and bearing data were memory mapped to provide a fast and flexible data path. Using only 6 watts of power, the card demonstrated resolution of 9 inches in free space (1.5 ns in time), amplitude resolution of 6 bits, and bearing accuracy and resolution equal to the performance of the host radar's optical encoder. GRA

N87-24607# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
EFFICIENT MULTICHIP PARTIAL CONCENTRATOR SWITCHES
Thomas H. Cormen Feb. 1987 13 p
(Contract N00014-80-C-0622)
(AD-A178334; MIT/LCS/TM-322) Avail: NTIS HC A02/MF A01 CSCL 09E

Due to chip area and pin count constraints, large concentrator switches sometimes must be partitioned among several chips. This paper presents designs for two multichip partial concentrator switches, both of which follow from a lemma showing that an epsilon nearsorter is also an (n, m, 1-epsilon/m) partial concentrator. GRA

N87-24608# FOM-Inst. voor Plasmafysica, Rijnhuizen, Jutphaas (Netherlands).
THEORY AND DESIGN OF A TE(01)-TE(11) MODE CONVERTER
C. A. J. vanderGeer Dec. 1986 34 p Sponsored by Euratom, and Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek
(Rept-86-163; ETN-87-98528) Avail: NTIS HC A03/MF A01

The Maxwell equations are transformed into generalized telegraphist equations, a set of linear differential equations equal to the set of equations describing the currents and voltages in mutually coupled transmission lines or in mutually coupled tuned LC-circuits. Each mode can then be identified with the current in one of the circuits. Power can be transferred from one circuit to another with different resonant frequency by reversing the sign of the coupling. In the microwave analogon this corresponds to a change of curvature along the axis of the guide which leads to a wiggling axis. In order to keep reflections low, the curvature should not change abruptly. This also simplifies the calculations. For practical reasons both ends of the converter should have the same direction and all wiggles should have the same form. ESA

N87-24609# Joint Publications Research Service, Arlington, Va.
USSR REPORT: ELECTRONICS AND ELECTRICAL ENGINEERING
8 Apr. 1987 83 p Transl. into ENGLISH from various Russian articles
(JPRS-UEE-87-005) Avail: NTIS HC A05/MF A01

Abstracts of periodical literature covering various areas of electrical and electronic engineering are compiled. Subject categories include signal processing, radio navigation equipment, antennas and propagation, consumer electronics, communciations, microwave equipment, instrumentation, power engineering, and solid state circuits. For individual titles, see N87-24610 through N87-24620.

N87-24610# Joint Publications Research Service, Arlington, Va.
ROUNDING NOISE IN M-STAGE RECURSIVE DIGITAL FILTER Abstract Only **c32**
V. A. Geranin, L. I. Kotlyar, and P. A. Markelov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 1 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR) no. 7, Jul. 1986 p 10-15 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

Noise at the output of an M-stage recursive digital filter caused by rounding the results of arithmetic operations with a floating decimal point, results of additions and multiplications, is analyzed starting with the difference equation for the i-th stage of an ideal biquadratic array. In the direct configuration of a real biquadratic array the response of the i-th filter stage with a transfer function H(sub i)(z) = B(sub i)(z) A(sub i)sup -1 (z) (the transfer function of the nonrecursive part = B(sub i)(z), the recursive part = A(sub i)sup -1 (z), and i = 1,...,M) is treated as the response of a recursive digital filter with the transfer function A(sub i)sup -1 (z) to white sieve noise. In the canonical configuration of a real biquadratic array noise in both parts is also shown to be equivalent to white sieve noise. The dispersion of the rounding error is calculated accordingly, whereupon is determined the number of digits in the mantissa in the summators necessary for not exceeding the allowable dispersion. Author

N87-24611# Joint Publications Research Service, Arlington, Va.
ALGORITHM OF SPACE PROCESSING OF SIGNALS AND INTERFERENCE FOR ELECTROMAGNETIC COMPATIBILITY Abstract Only **c32**
A. P. Rodimov, V. V. Nikitchenko, and L. M. Konovalov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 2 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 54-56 Original language document was announced in IAA as A87-15567 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

A method for the spatial processing of signals and noise in communication lines is examined which is based on the broadening of the signal (noise) band in directions different from a specified one, as the result of cyclic switching of space-diversity antenna elements. The algorithm is easy to realize, invariant to the type of noise, and sufficiently efficient in narrow-band operating modes in the presence of medium-intensity noise. IAA

N87-24612# Joint Publications Research Service, Arlington, Va.
OPTIMIZATION OF SPACE-TIME PROCESSING ALGORITHMS FOR RADIO SIGNALS Abstract Only **c32**
A. S. Bogachev *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 3 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 4, Apr. 1986 p 3-7 Original language document was announced in IAA as A86-39681 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

Quasi-optimal continuous nonlinear filtering algorithms using the Gaussian approximation are applied to problems of the synthesis of radio systems with spatial-temporal signal processing which employ multidimensional array antennas. Equations are obtained for estimating the state vector and the covariance matrix of filtering errors associated with the use of two-dimensional and three-dimensional arrays. IAA

N87-24613# Joint Publications Research Service, Arlington, Va.
SYNTHESIS OF DEVICES FOR OPTIMAL PROCESSING OF RADIO PULSE SIGNALS IN LONG-RANGE RADIO NAVIGATION SYSTEMS Abstract Only **c04**
P. P. Filatov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 5 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 16-19 Original language document was announced in IAA as A87-15563 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

A receiver of radio pulse signals for long-range radio navigation systems, optimum with respect to both accuracy and interference immunity, is synthesized in accordance with the Markov theory of optimal nonlinear discrete-analog filtration for minimum fadeout. Calculations are based on a model of such a system and its operation which adequately decribes the state vector, with inclusion of singularities resulting from time discretization of continuous navigation parameters. The receiver is accordingly a nonlinear filter consisting of an estimator of state vector components, an optimum multidimensional discriminator, and a phase-lock automatic frequency control, with amplifier stages providing the necessary gain and cross-coupling. There are two channels for estimating the signal amplitude in the master station and in the follower station respectively. Performance characteristics with typical numerical data are shown based on solution of the two equations of a posteriori second central moments. Author

N87-24614# Joint Publications Research Service, Arlington, Va.
MEASURING INSTRUMENTS FOR RADIO NAVIGATION BASED ON SERIES K588 MICROPROCESSOR SETS Abstract Only **c04**
G. N. Gromov, V. V. Gavrishchuk, R. V. Drozdov, Yu. T. Krivoruchko, B. V. Ponomarenko, and L. I. Chukanov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 6-7 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 77-80 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

Modern on-board scanning and tracking instruments for radio navigation are built on a microprocessor set base, 16-bit microprocessors being most satisfactory for this application. These instruments generally operate according to Markov's theory of optimal nonlinear filtration. Series 588 microprocessor sets have hardware and software compatible with various microcomputers such as Elekronika-NTs-80-01 and software compatible with SM minicomputers. They have a modular architecture with intermodular links through parallel interfaces, they are asynchronous and microprogrammable. Author

N87-24615# Joint Publications Research Service, Arlington, Va.
SIGNAL PROCESSING IN MULTIPOSITIONAL RADAR SYSTEMS Abstract Only **c32**
V. M. Petrov and T. G. Vyatkina *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 8 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 46-49 Original language document was announced in IAA as A87-15564 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

An analysis is made of the reduction efficiency of external noise in coherent multipositional radar systems using quasi-optimal signal combination based on the separation of the signal processing. It is shown that the quasi-optimal method has practically the same noise reduction efficiency as the optimal method when the parameters of the antenna system (e.g., the number and location of the reception points, and the sidelobe level of spatial correlation functions of individual phased arrays) are suitably chosen. IAA

N87-24616# Joint Publications Research Service, Arlington, Va.
RESULTS OF MEASURING OPTICAL THICKNESS OF ATMOSPHERE AT LINES OF OZONE'S ROTATIONAL SPECTRUM Abstract Only **c46**
Yu. Yu. Kulikov and V. G. Ryskin *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 11 Transl. into ENGLISH from Radiotekhnia (Moscow, USSR), no. 7, Jul. 1986 p 92-93 Original language document was announced in IAA as A87-15572 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

Measurements of the two most intense atmospheric ozone lines in the millimeter range (142.175 and 101.736 GHz) under different climatic conditions are compared. Multichannel spectrum analyzers operating at 110-150 and 80-110 GHz with a frequency resolution of 3 MHz in each channel and an analysis band of 100 MHz were used. The intensity and width of the lines are found to depend on the ozone content in the stratosphere. IAA

N87-24617# Joint Publications Research Service, Arlington, Va.
RECTANGULAR WAVEGUIDE H10 MODE DIFFRACTION IN ARRAY OF CIRCULAR INDUCTIVE RODS Abstract Only **c32**
A. M. Model and A. Yu. Savitskiy *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 54 Transl. into ENGLISH from Radiotekhnika (Moscow, USSR), no. 4, Aug. 1986 p 13-18 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

Previous computer aided design procedures for waveguide bandpass filters using an array of rods in the wavelength window could not produce windows with a susceptance up to 200 and an error of no more than 5%, which means defining the reflection factor within 1 x 10(-6). The best effort resulted in a window with three rods having a susceptance of about 40 with an error of approximately 8%. This paper derives the mathematical tools for the computer aided solution of H10 mode diffraction in a rectangular waveguide by an array of equally spaced, circular inductive rods. The procedure provides for the accurate calculation of the reflection factor from the window where the susceptance can run up to 300 (the divergence between the calculated and experimental values is about 5% for a susceptance of 150 and 14% for a value of 300 using a FORTRAN program on a YeS computer). Increasing the number of line currents in each rod up to 20 reduced the disparity to 5% for a susceptance of 300. Author

N87-24618# Joint Publications Research Service, Arlington, Va.
VA02 SERIES OF HIGH VOLTAGE EXPLOSION-PROOF ASYNCHRONOUS MOTORS Abstract Only
V. F. Goryagin, L. A. Zbarskiy, I. G. Shirnin, Yu. V. Porshnev, and M. I. Figotina *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 57 Transl. into ENGLISH from Elektrotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 19-22 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

The VAO2 asynchronous, squirrel cage, explosion-proof electric motors have the same power and r.p.m. range, the same weather, water and dust proofing as the predecessor VAO series and are designed for the same explosion hazards. The nominal r.p.m. ranges from 750 to 3,000, the power ratings from 200 to 1,000 kW, voltage ratings are 6,000 and 10,000 volts with efficiencies running from 93.4 to 95.6% and weights of 1,620 to 5,700 kg. The new VAO2 motors incorporate the following improvements: the use of cold rolled electrical steel with lower specific losses; the use of a bottle configuration for the rotor slot instead of the usual oval; an improved exterior cooling system; and a reduction in the average insulation thickness. Author

N87-24619# Joint Publications Research Service, Arlington, Va.
WAYS OF DECREASING METAL INPUT REQUIREMENTS AND IMPROVING PARAMETERS OF EXPLOSION-PROOF ELECTRIC MOTORS Abstract Only
A. S. Ponizko *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 58 Transl. into ENGLISH from Elektrotekhnika (Moscow, USSR), no. 7, Jul. 1986 p 22-24 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

The specific metal input requirements for the construction of explosion-proof electric motors can be reduced by improving the forced-air cooling and relieving the explosion hazardous pressure through the use of gas permeable fire barriers. Quantitative

estimates of the cooling efficiency for explosion-proof, asynchronous motors cooled by a twin blower mounted on the motor shaft are provided. The ventilation inside the explosion-proof containment is accomplished by the air from the inside blower of the fan assembly being sucked through the porous elements from the working end of the shaft, passed through the rotor channels, through the porous elements of the second bearing shield plate, and directed by the vanes of the fan into the air flow coming from the outer forced-air circulating blower. Calculations of the air flow, temperature and cooling efficiency are given for a four-pole 160 kW VAO315M-4 motor. The performance of the porous fire barriers in industry environments is also discussed. Author

N87-24620# Joint Publications Research Service, Arlington, Va.
PHOTON FIELD-EFFECT TRANSISTORS BASED ON GALLIUM-ARSENIDE AND ITS SOLID SOLUTIONS Abstract Only
Yu. M. Zadiranov, V. I. Korolkov, and A. V. Rozhkov *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 67 Transl. into ENGLISH from Mikroelektronika (Moscow, USSR), v. 15, no. 5, Sep. - Oct. 1986 p 464-466 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

Results of an investigation of the principal characteristics of photon field-effect transistors based on GaAs and solid solutions of AlGaAs are presented. The basic difference between a photon field-effect transistor and similar devices is the presence of an optical connection between components of its elements. As a result of excluding the diffusion processes for transfering minority charge carriers from the site of their injection to the site of separation by the collector p-n junction, the change-over time can be reduced to 10(-8) to 10(-9) second. The zonal energy diagram selected and the preparation assure internal positive connection and make it possible to obtain devices with various kinds of volt-ampere characteristics. Author

N87-24621# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Product Assurance Div.
THE CAPABILITY APPROVAL PROGRAM FOR HERMETIC THICK-FILM HYBRID MICROCIRCUITS
Jul. 1986 100 p
(ESA-PSS-01-606-Iss-1; ISSN-0379-4059; ETN-87-99849)
Copyright Avail: NTIS HC A05/MF A01

An ESA specification which defines the general requirements for capability approval of a manufacturing line for hermetic thick film hybrid microcircuits is presented. ESA

N87-24622# European Space Agency, Paris (France).
INVESTIGATIONS ON A BROADBAND 180 DEG HYBRID
Manfred Weisser and Karl Hans Waegel Dec. 1986 38 p Transl. into ENGLISH of "Untersuchungen an einem Breitbandigen 180 deg Hybrid" DFVLR, Oberpfaffenhofen (West Germany), Feb. 1986 Original language document was previously announced as N87-14616
(ESA-TT-1018; DFVLR-FB-86-22; ETN-87-99855) Avail: NTIS HC A03/MF A01; original German version available from DFVLR, Cologne, West Germany DM 15

An asymmetrically supplied rectangular waveguide bifurcation with cascaded multiports was developed. An intermediate circuit consisting of diaphragms and conductors is provided for broadband matching transformations. The computation of the scattering matrices of the multiports is based on a field matching method. It is shown that an equal power division is difficult to realize for a 180 deg phase shift between the ouput signals. The always present excitation of disturbing mode reduces the bandwidth by tens of MHz. The practical realization is a power divider at 9.6 GHZ with a 90 deg phase difference between the output signals and a bandwidth of 900 MHz. ESA

N87-24623# Sandia National Labs., Albuquerque, N. Mex.
STUDIES OF LOW-EMITTANCE ELECTRON DIODES
J. W. Poukey Mar. 1987 68 p
(Contract DE-AC04-76DP-00789)
(DE87-008398; SAND-87-0384) Avail: NTIS HC A04/MF A01

Recent studies of non-immersed foilless electron diodes are summarized. The tools used include trajectory and particle simulation codes. Systems studied include Delphi, Troll, and LANL test diode, and an FEL source. In terms of computational efficiency, the trajectory code is found to be generally better for this type of problem. In terms of design results, the short solenoid, or focus coil, is found to be very useful in guiding beams in the kA range without large emittance gains. A high-current linac is also briefly discussed. DOE

N87-24624# Oak Ridge National Lab., Tenn.
GAS ENGINEERING STUDIES FOR HIGH PRESSURE SELF-SUSTAINED DIFFUSE DISCHARGE CLOSING SWITCHES
S. R. Hunter, L. G. Christophorou, and J. G. Carter 1987 9 p Presented at the 5th International Symposium on Gaseous Dielectrics, Knoxville, Tenn., 3 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-008826; CONF-870516-5) Avail: NTIS HC A02/MF A01

The operating voltage and discharge stability of diffuse discharges for fast-closing switch applications are critically dependent on the variation of the ionization (alpha/N) and attachment (eta/N) coefficients with E/N (gas density normalized electric field strength). Gases and gas mixtures which possess low (E/N)/sub lim/ values (i.e., the E/N value when anti alpha/N = alpha/N - eta/N = 0) and effective ionization coefficients, anti alpha/N, which vary slowly with E/N near (E/N)(sub lim) lead to lower voltage (i.e., more efficient) operation with increased discharge stability. Several gas mixtures with these characteristics are discussed. It is argued that further improvements in switch efficiency and discharge stability can be obtained by adding a low ionization onset gas additive to these binary mixtures, such that at low E/N, alpha/N is greater than eta/N, while at higher E/N, eta/N is greater than alpha/N over a restricted E/N range. Several low ionization onset gas additives are suggested and the electron attachment and ionization coefficients in selected gas mixtures which possess these desirable characteristics are given. DOE

N87-24625# Argonne National Lab., Ill.
MEASUREMENT OF STIBINE AND ARSINE GENERATION FROM THE EXIDE 3100-AH LEAD-ACID MODULE
J. J. Marr and J. A. Smaga Jan. 1987 18 p
(Contract W-31-109-eng-38)
(DE87-009461; ANL-87-1) Avail: NTIS HC A02/MF A01

Stibine and arsine evolution from lead-acid cells in a 36-kWh Exide load-leveling module was measured as this module approached 1900 cycles of operation. A specially prepared gas-collection apparatus enabled us to determine the maximum and average rates for evolution of both toxic hydrides. Hydride generation began once the cell voltage exceeded 2.4 V. The maximum rate for arsine occurred just above 2.5 V and consistently preceded the peak rate for stibine for each sampled cell. When adjusted for size effects, the degree of stibine and arsine evolution was greater than found in a continuous overcharge study conducted by Exide. The average rates of hydride generation were found to be 175 microgram/min for stibine and 12.6 microgram/min for arsine. The former rate proved to be the critical value in determining safe ventilation requirements for cell off-gases. The minimum airflow requirement was calculated to be 340 L/min per cell. Projections for a hypothetical 1-MWh Exide battery without an abatement system indicated that the normal ventilation capacity in the Battery Energy Storage Test facility provides nearly five times the airflow needed for safe hydride removal. DOE

N87-24626# Standard Elektrik Lorenz A.G., Stuttgart (West Germany). Forschungsinst.
DESIGN OF LOW-VOLUME, HIGH QUALITY, LOW COST, VLSI CUSTOM CIRCUITS Final Report, Jan. 1985
Clem Austen, Tillmann Eckstein, Wolfgang Fonden, Helmut Gross, Peter Killius, Gisla Klinger, Monika Kniel, Karin Lassek, Heiko Rabethge, Phil Radford et al. Bonn, West Germany BMFT Dec. 1986 299 p In GERMAN; ENGLISH summary Sponsored

by BMFT
(BMFT-FB-T-86-082; ISSN-0340-7608; ETN-87-99692) Avail: NTIS HC A13/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 46.50

A design system based on standard cell customer LSI was developed. Design rules for 3 micron NMOS technologies were derived. Based on these design rules, a cell library consisting of 75 cells was worked out. A test chip was created to characterize the cell library. An integrated CAD system was developed; a qualification procedure was proposed. The simulation program SPICE 2G5 was modified in the MOS part and an extraction procedure for the parameters was created. Examples of circuits were analyzed using design centering. The design centering method provides information about the functionality of a circuit, allowing an optimization of the yield in consideration of the manufacturing process. This procedure can also be applied for cost reduction. ESA

N87-24627# Gesamthochschule, Siegen (West Germany). Inst. fuer Datenverarbeitung.
ANALYSIS OF LOGIC SIMULATORS FOR DIGITAL CIRCUITS WITH A VIEW TO THE POSSIBILITY TO LINK THEM TO AUTOMATIC TEST SYSTEMS USING A UNIVERSAL INTERFACE Final Report, Mar. 1986
Armin Adam, Uwe Schroeder, and Juergen Schneider Bonn, West Germany BMFT Dec. 1986 97 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-115; ISSN-0340-7608; ETN-87-99702) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20

A universal, simulator-independant interface supporting an extensively automatic test pattern generation, was studied. Simulators on the market were analyzed with respect to their capability and market relevance. On the basis of a market analysis the best simulators were identified. The interfaces of the simulators and international standardization proposals were investigated. Simulators LASAR, HILO and CADAT were selected, and EDIF was found to be an appropriate interchange format. The universal interface design and test can be realized. ESA

N87-24628# Army Military Personnel Center, Alexandria, Va.
LOW NOISE AMPLIFIER FOR USE WITH SUBMILLIMETER ELECTRIC-FIELD PROBES Final Report
Steve Pavlica May 1987 94 p
(AD-A180132) Avail: NTIS HC A05/MF A01 CSCL 09A

In the past several years, there has been increasing concern over the effects on human beings of low level electromagnetic radiation. Submillimeter Electric Field probes were developed to directly measure E fields in biological media. These probes are also very useful for measuring E fields in cavities where solving the mathematical equations, because of the geometries of the cavities, is very difficult or impossible. An amplification system for these probes is investigated. This system is designed, built, and laboratory tested. A theoretical gain equation is developed relating the output voltage of the system to the impinging E field on the probe. Additionally, a complete noise analysis is accomplished. Theoretical noise work is verified in the laboratory, along with the gain equation. Finally, modulation of the probe amplifier system is shown to be feasible and is demonstrated in the laboratory. This will allow the measurement of the relative phase shift between two points in a cavity. GRA

N87-24629# North Carolina State Univ., Raleigh.
LEADERSHIP IN MICROSTRUCTURES TECHNOLOGY: A REPORT OF THE STEERING COMMITTEE FOR THE WORKSHOP ON THE FUTURE OF MICROSTRUCTURES TECHNOLOGY, HELD IN SEABROOK ISLAND, SOUTH CAROLINA ON OCTOBER 13-15, 1985 Final Report, 27 Aug. - 31 Dec. 1985
M. A. Littlejohn Apr. 1987 19 p
(Contract MIPR-ARO-164-85)
(AD-A180166; ARO-23316.1-EL-CF) Avail: NTIS HC A02/MF A01 CSCL 09A

Microstructures technology is the key component of the microelectronics revolutions, which is causing profound and rapid changes in information processing, computation, robotics, communications, manufacturing, national security, and international trade. The current leadership of the United States is being vigorously challenged by other countries. To maintain a leadership position, or even a competitive position, adequate funding of near-term and long-term research at universities and non-profit laboratories is essential, along with improved transfer of results from the research laboratory to commericial products. We recommend enhanced and well-targeted funding of microstructure technology and research. GRA

N87-24630*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SELF-CONSISTENT INCLUSION OF SPACE-CHARGE IN THE TRAVELING WAVE TUBE
Jon C. Freeman Jul. 1987 49 p
(NASA-TM-89928; E-3633; NAS 1.15:89928) Avail: NTIS HC A03/MF A01 CSCL 09C

It is shown how the complete field of the electron beam may be incorporated into the transmission line model theory of the traveling wave tube (TWT). The fact that the longitudinal component of the field due to the bunched beam is not used when formulating the beam-to-circuit coupling equation is not well-known. The fundamental partial differential equation for the traveling wave field is developed and compared with the older (now standard) one. The equation can be solved numerically using the same algorithms, but now the coefficients can be updated continuously as the calculation proceeds down the tube. The coefficients in the older equations are primarily derived from preliminary measurements and some trial and error. The newer coefficients can be found by a recursive method, since each has a well defined physical interpretation and can be calculated once a reasonable first trial solution is postulated. The results of the new expression were compared with those of the older forms, as well as to a field theory model to show the ease in which a reasonable fit to the field prediction is obtained. A complete summary of the existing transmission line modeling of the TWT is given to explain the somewhat vague ideas and techniques in the general area of drifting carrier-traveling circuit wave interactions. The basic assumptions and inconsistencies of the existing theory and areas of confusion in the general literature are examined and hopefully cleared up. Author

N87-24631*# Technion - Israel Inst. of Tech., Haifa.
ELECTRONIC HETERODYNE MOIRE DEFLECTOMETRY: A METHOD FOR TRANSIENT AND THREE DIMENSIONAL DENSITY FIELDS MEASUREMENTS Annual Report
Josef Stricker Jul. 1987 54 p
(Grant NAGw-933)
(NASA-CR-181134; NAS 1.26:181134) Avail: NTIS HC A04/MF A01 CSCL 09C

Effects of diffraction and nonlinear photographic emulsion characteristics on the performance of deferred electronic heterodyne moire deflectometry are investigated. The deferred deflectometry is used for measurements of nonsteady phase objects where it is difficult to complete the analysis of the field in real time. The sensitivity, accuracy and resolution of the system are calculated and it is shown that they are weakly affected by diffraction and by nonlinear recording. The feactures of the system are significantly improved compared with the conventional deferred intensity moire technique, and are comparable with the online heterodyne moire. The system was evaluated experimentally by deferred measurements of the refractive index gradients of a weak phase object consisting of a large KD*P crystal. This was done by photographing the phase object through a Ronchi grating and analyzing the tranparency with the electronic heterodyne readout system. The results are compared with the measurements performed on the same phase object with online heterodyne moire deflectometry and with heterodyne holographic interferometry methods. Some practical considerations for system improvement are discussed. Author

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N87-24632# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

NUMERICAL STUDY OF SUPERSONIC FLOWS USING DIFFERENT TECHNIQUES M.S. Thesis

Gary W. Huband Dec. 1986 85 p

(AD-A179113; AFIT/GA/AA/86D-8) Avail: NTIS HC A05/MF A01 CSCL 20D

The purpose of this work was to obtain the solution to three supersonic flow problems using three different numerical techniques. First, a shock/boundary layer problem is solved using MacCormack's explicit technique. Then, using the same technique a shrouded rocket nozzle problem is solved. These two problems showed that the explicit scheme required many minutes of computer time to solve. In order to explore more efficient codes to solve the shroud problem, space marching algorithms were studied. A space marching algorithm using flux-splitting in the streamwise direction was applied to an approximate form of the Navier-Stokes equation. Flux-splitting combined with a global interation approach should allow the shroud problem to be solved with a space marching algorithm. The flux-splitting code was applied to two supersonic flow problems and very good results were obtained. GRA

N87-24633# Ballistic Research Labs., Aberdeen Proving Ground, Md.

PRESSURE MEASUREMENTS IN A LIQUID FILLED CYLINDER USING A THREE DEGREE OF FREEDOM FLIGHT SIMULATOR Final Memorandum Report

David J. Hepner, Thomas M. Kendall, Bradford S. Davis, and William Y. Tenly Dec. 1986 30 p

(AD-A177872; BRL-MR-3560) Avail: NTIS HC A03/MF A01 CSCL 19D

A three degree of freedom flight simulator was used to simulate the angular motion of a spin-stabilized projectile in order to measure internal pressures on a liquid filled cylinder. The flight stability of liquid filled shell is often determined by linearized theory and tests of subscale models. This simulator is sufficiently large to produce full scale tests and can acomodate a large number and variety of transducers. Pressure and accelerometer measurements were taken in a continuous fashion on a liquid filled cylinder endwall and sidewall. The Reynolds number was 18,200. Tests at several different amplitudes of yaw allowed for comparisons with linear theory. Nonlinear trends were observed. Measurements of the phase difference between the pressure and the yawing motion are presented. Pressure data are available for prograde and retrograde yawing motion, and they provide a verification of the theory applications for a wide range of the coning frequency. GRA

N87-24634# Air Force Armament Lab., Eglin AFB, Fla.

TURBULENT FLOW OVER AN EMBEDDED RECTANGULAR CAVITY Final Report, 30 Jun. - 5 Sep. 1986

George D. Catalano Feb. 1987 36 p

(AD-A177928; AD-E801466; AFATL-TR-86-73) Avail: NTIS HC A03/MF A01 CSCL 20D

A numerical, discrete vortex model is developed for flow over an embedded rectangular cavity, with the separation of the shear layer at the leading edge replaced by periodic insertion of point vortices. The results of the vortex model are compared to the data obtained from an experimental investigation carried out at a free stream speed of 6 m/sec past a rectangular cavity of depth, D equal to 5 cm; a depth-to-width ratio, D/W equal to 1.0 and length-to-depth ratio, L/D, equal to 4.0. The Reynolds numbers based on the cavity depth is approximately 2 x 104. Mean velocity, and turbulent intensity, profiles are presented. Evidence of the three dimensional nature of the flow has been obtained via oil film and tuft flow visualization techniques. Discrepancies between the model predictions and the experimental results are discussed as are differences between the 3-D flow field examined here and previous infinite span, 2-D, cavity configurations. Additionally, a mechanism is developed for the inclusion in the vortex model of various initial separation conditions. GRA

N87-24635# Old Dominion Univ., Norfolk, Va. Dept. of Oceanography.

MODIFICATION OF SEPARATING FLOW Interim Report, for Period Ending 30 Jun. 1985

Cheser E. Grosch Feb. 1987 7 p

(Contract N00014-84-K-0505)

(AD-A178417) Avail: NTIS HC A02/MF A01 CSCL 20D

The usual physical description of separation is that an adverse pressure gradient causes the deceleration of the low momentum flow near the surface. The result is a reduction of the velocity near the surface and a corresponding decrease in the shear at the wall as the slope of the velocity profile decreases. Finally, at some point, the shear stress at the wall vanishes and the flow separates. Downstream of this point the flow near the boundary reverses and a dividing streamline breaks away from the surface. Below this streamline the net flow is towards the separation point and above this streamline it is away from the separation point. This general type of flow field can generally be observed near the rear of bodies, in particular, flow separation occurs on the rearward part of bodies with a blunt shape. GRA

N87-24636# Sandia National Labs., Albuquerque, N. Mex.

NUMERICAL MODELING OF CHEMICALLY REACTING FLUID FLOW IN A CLOSED VOLUME

V. L. Behr and D. C. Chou 1987 19 p Presented at the 19th Fluid Dynamics, Plasma Dynamics and Laser Conference, Honolulu, Hawaii, 8 Jun. 1987 Prepared in cooperation with United International Engineering, Inc., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(DE87-001415; SAND-86-2410C; CONF-870622-1) Avail: NTIS HC A02/MF A01

The numerical modeling of chemically reactive fluid flow is a very difficult problem. Differing time scales for the chemical processes from the fluid processes are partially responsible for the difficulty involved. The chemical reactions take place in a very thin layer known as the flame front. The thickness of the flame front is very thin compared to a typical grid size used for computational fluid dynamics. Thus resolution of the flame zone requires the use of either a variable grid approach or a coordinate transformation. Experiments have been conducted involving the combustion of lean mixtures of hydrogen and air. A cursory review of the results seems to indicate combustion occurring in a one-dimensional fashion. An existing computer code known as CONCHAS:SPRAY has been modified to model these combustion experiments. An extensive parametric study that was performed in an attempt to achieve good agreement between the experimental and numerical results achieved with a one-dimensional model is discussed. The experimental results are examined in more detail to reveal the importance of multi-dimensional effects. DOE

N87-24637# Los Alamos National Lab., N. Mex.

THERMOCHEMICAL MODELING OF MASS TRANSPORT IN HIGH-TEMPERATURE HEAT PIPES

R. C. Feber and M. A. Merrigan 1987 7 p Presented at the 6th International Heat Pipe Conference, Grenoble, France, 25 May 1987

(Contract W-7405-eng-36)

(DE87-007484; LA-UR-87-911; CONF-870585-1) Avail: NTIS HC A02

A dynamic model of mass transport due to nonmetallic contaminants in refractory metal-alkali metal heat pipes has been developed. The model has been applied to heat pipes proposed for applications in space power systems using actual dimensions and powers. Results have been used to predict the operating

lifetimes of the systems and to suggest mechanisms for mass transport observed in extended laboratory tests. Limitations of the model due to uncertainties in data for the effect of oxygen and nitrogen on the solubility of refractory metals in the alkali metals are discussed. DOE

N87-24638# Oak Ridge Gaseous Diffusion Plant, Tenn.
BOUNDARY ELEMENT METHOD FOR THREE-DIMENSIONAL HEAT TRANSFER IN REGIONS WITH SYMMETRY
G. E. Giles, L. J. Gray, and M. W. Wendel 1987 8 p Presented at the 22nd AIAA Thermophysics Conference, Honolulu, Hawaii, 8 Jun. 1987 Prepared in cooperation with ORNL, Tenn.
(Contract DE-AC05-84OR-21400)
(DE87-007575; K/CSD/INF-86/21; CONF-870623-2) Avail: NTIS HC A02

Steady-state heat transfer through a contact region (circular and elliptical) is solved numerically by the boundary element method. Exploiting the symmetry of the problem, specialized Green's functions are employed, thereby considerably simplifying the task of constructing an appropriate mesh (i.e., highly refined near the contact edge). Moreover, accurate fluxes for this difficult problem are obtained utilizing a new extrapolation technique for treating the edge discontinuity. The application of specialized Green's functions is also illustrated on another three-dimensional problem of practical importance, that of temperature profiles in an electrochemical plating cell. DOE

N87-24639*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THREE-STEP CYLINDRICAL SEAL FOR HIGH-PERFORMANCE TURBOMACHINES
Robert C. Hendricks Jun. 1987 79 p
(NASA-TP-1849; E-3185; NAS 1.60:1849) Avail: NTIS HC A05/MF A01 CSCL 20D

A three-step cylindrical seal configuration representing the seal for a high performance turbopump (e.g., the space shuttle main engine fuel pump) was tested under static (nonrotating) conditions. The test data included critical mass flux and pressure profiles over a wide range of inlet temperatures and pressures for fluid nitrogen and fluid hydrogen with the seal in concentric and fully eccentric positions. The critical mass flux (leakage rate) was 70% that of an equivalent straight cylindrical seal with a correspondingly higher pressure drop based on the same flow areas of 0.3569 sq cm but 85% that of the straight seal based on the third-step flow area of 0.3044 sq cm. The mass flow rates for the three step cylindrical seal in the fully eccentric and concentric positions were essentially the same, and the trends in flow coefficient followed those of a simple axisymmetric inlet configuration. However, for inlet stagnation temperatures less than the thermodynamic critical temperature the pressure profiles exhibited a flat region throughout the third step of the seal, with the pressure magnitude dependent on the inlet stagnation temperature. Such profiles represent an extreme positive direct stiffness. These conditions engendered a crossover in the pressure profile upstream of the postulated choke that resulted in a local negative stiffness. Flat and crossover profiles resulting from choking within the seal are practically unknown to the seal designer. However, they are of critical importance to turbomachine stability and must be integrated into any dynamic analysis of a seal of this configuration. In addition, choking is highly dependent on geometry, inlet-to-backpressure ratio, and inlet temperature and can occur within the seal even though the backpressure is above the critical pressure. M.G.

N87-24640*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
INTERACTION BETWEEN A VORTEX AND A TURBULENT BOUNDARY LAYER. PART 1: MEAN FLOW EVOLUTION AND TURBULENCE PROPERTIES
Russell V. Westphal, Wayne R. Pauley, and John K. Eaton (Stanford Univ., Calif.) Jan. 1987 47 p
(NASA-TM-88361; A-86408; NAS 1.15:88361) Avail: NTIS HC A03/MF A01 CSCL 20D

An experimental study was conducted to examine the interaction between a single weak streamwise vortex and a two-dimensional turbulent boundary layer. Attention was focused on characterizing the effect of the boundary layer on the vortex, including the effects of a moderate adverse pressure gradient. Rapid growth of the vortex core was observed, and a flattening of the core shape occurred when the dimension of the core radius became comparable to the distance of the vortex center from the surface. Adverse pressure gradients caused an increase in the rate of core growth, and therefore, a stronger distortion of the core shape. Measurements of surface skin friction beneath the vortex and some of the Reynolds stresses are presented. Author

N87-24641*# Beech Aircraft Corp., Boulder, Colo.
SPACE STATION EXPERIMENT DEFINITION: LONG-TERM CRYOGENIC FLUID STORAGE Final Report
R. L. Jetley and R. D. Scarlotti Washington NASA Jun. 1987 257 p
(Contract NAS3-24661)
(NASA-CR-4072; E-3463; NAS 1.26:4072; BAC-ER-18056-8)
Avail: NTIS HC A12/MF A01 CSCL 20D

The conceptual design of a space station Technology Development Mission (TDM) experiment to demonstrate and evaluate cryogenic fluid storage and transfer technologies is presented. The experiment will be deployed on the initial operational capability (IOC) space station for a four-year duration. It is modular in design, consisting of three phases to test the following technologies: passive thermal technologies (phase 1), fluid transfer (phase 2), and active refrigeration (phase 3). Use of existing hardware was a primary consideration throughout the design effort. A conceptual design of the experiment was completed, including configuration sketches, system schematics, equipment specifications, and space station resources and interface requirements. These requirements were entered into the NASA Space Station Mission Data Base. A program plan was developed defining a twelve-year development and flight plan. Program cost estimates are given. Author

N87-24642*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DIRECT SIMULATION OF A TURBULENT OSCILLATING BOUNDARY LAYER
Philippe R. Spalart and Barrett S. Baldwin May 1987 9 p
(NASA-TM-89460; A-87220; NAS 1.15:89460) Avail: NTIS HC A02/MF A01 CSCL 20D

The turbulent boundary layer driven by a freestream velocity that varies sinusoidally in time around a zero mean is considered. The flow has a rich behavior including strong pressure gradients, inflection points, and reversal. A theory for the velocity and stress profiles at high Reynolds number is formulated. Well-resolved direct Navier-Stokes simulations are conducted over a narrow range of Reynolds numbers, and the results are compared with the theoretical predictions. The flow is also computed over a wide range of Reynolds numbers using a new algebraic turbulence model; the results are compared with the direct simulations and the theory. Author

N87-24643*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLOW VISUALIZATION STUDY OF A TWO-DIMENSIONAL REPRESENTATION OF THE SPACE SHUTTLE LAUNCH PAD CONFIGURATION
B. G. McLachland, G. G. Zilliac, and S. S. Davis Jun. 1987 17 p
(NASA-TM-89440; A-87151; NAS 1.15:89440) Avail: NTIS HC A02/MF A01 CSCL 20D

The loss of the Space Shuttle Challenger was caused by the failure of the aft joint O-ring seals in its right solid rocket booster. It has been suggested by several sources that wind conditions through a reduction in temperature of the right solid rocket booster caused by the wind blowing across the cold external tank, played a role in the O-ring failure. To check the plausibility of the wind theory, an experiment was carried out in a water towing tank to

visualize the flow past a two-dimensional model representing a cross section of the Space Shuttle launch configuration. The periodic formation of vortices was found to characterize the wake generated by the model. It is suggested that this organized motion in the flow is the dominant mechanism that accomplishes heat transfer from the external tank to the right solid rocket booster. Flow visualization results consisting of photographs that show instantaneous streamline patterns of the flow are presented.
Author

N87-24644# European Space Agency, Paris (France).
ANALYTIC SOLUTIONS OF THE NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS FOR TRANSONIC FLOW IN PHYSICAL SPACES
Kuang-Lai Chao Dec. 1986 42 p Transl. into ENGLISH of "Analytische Loesungen der Nichtlinearen Partiellen Differentialgleichungen fuer die Transsonische Stroemung in Physikalischen Raeumen" DFVLR, Goettingen (West Germany) Jan. 1986 Original language document was previously announced as N87-11705
(ESA-TT-1009; DFVLR-FB-86-14; ETN-87-99852) Avail: NTIS HC A03/MF A01; original German version available from DFVLR, Cologne, West Germany DM 15

The nonlinear partial differential equations for steady transonic flow were solved analytically in physical spaces using four different methods. Plane flow and axisymmetric flow were taken as examples to investigate the nonlinearity of the transonic equations; for both flows many solutions were found, including with a finite number of terms. An iteration method makes it possible to derive exact solutions from the nonlinear equations. The method of the separation of variables leads to new functions in conjunction with the Weierstrass elliptic function. ESA

N87-24645# European Space Agency, Paris (France).
UNSTEADY TRANSONIC FLOW COMPUTATIONS FOR AGARD TWO DIMENSIONAL AND THREE DIMENSIONAL AEROELASTIC CONFIGURATIONS
J. J. Angelini, P. Girodroux-Lavigne, J. P. Grisval, J. C. LeBalleur, P. Mulak, and J. Sides Dec. 1986 164 p Transl. into ENGLISH of "Calculs d'Aerodynamique Instationnaire sur les Configurations Aeroelastiques 2D et 3D Definis par l'AGARD", ONERA, Chatillon (France), 1985 Original language document was previously announced as N87-13418
(ESA-TT-1020; ONERA-NT-1985-5; ETN-87-99856) Avail: NTIS HC A08/MF A01

Numerical results on aeroelastic standard configurations are presented. The methods used for two dimensional configurations include the small perturbations approach for inviscid flow, coupling methods for unseparated flow, coupling methods for unseparated or separated, laminar or turbulent boundary layers, and a numerical solution of the Euler equations for inviscid flow. The three dimensional configurations are studied by the transonic small disturbance approach. The detailed results are given. ESA

N87-24646*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STABILITY OF A RIGID ROTOR SUPPORTED ON FLEXIBLE OIL JOURNAL BEARINGS
Bankim C. Majumdar, David E. Brewe, and Michael M. Khonsari (Ohio State Univ., Columbus.) 1987 29 p Proposed for presentation at the 1987 Joint Tribology Conference, San Antonio, Tex., 5-8 Oct. 1987; sponsored by the American Society of Lubrication Engineers and ASME
(NASA-TM-89899; E-3408; NAS 1.15:89899; AVSCOM-TR-87-C-12) Avail: NTIS HC A01/MF A01 CSCL 20D

This investigation deals with the stability characteristics of oil journal bearings, including the effect of elastic distortions in the bearing liner. Graphical results are presented for (1) steady-state load, (2) stiffness and damping coefficients, and (3) the stability. These results are given for various slenderness ratios, eccentricity ratios, and elasticity parameters. The lubricant is first assumed to be isoviscous. The analysis is then extended to the case of a pressure-dependent viscosity. It has been found that stability decreases with increase of the elasticity parameter of the bearing liner for heavily loaded bearings. Author

N87-24647# Lawrence Livermore National Lab., Calif.
A SECOND-ORDER PROJECTION METHOD FOR VISCOUS, INCOMPRESSIBLE FLOW
J. B. Bell, P. Colella, and H. M. Glaz Apr. 1987 19 p Presented at the 8th American Institute of Aeronautics and Astronautics Computational Fluid Dynamics Conference, Honolulu, Hawaii, 9 Jun. 1987 Prepared in cooperation with Maryland Univ., College Park
(Contract W-7405-eng-48)
(DE87-008209; UCRL-96428; CONF-8706104-1) Avail: NTIS HC A02/MF A01

Described is a second-order projection method for the time-dependent, incompressible Navier Stokes equations. The numerical method consists of three separate parts: a time-stepping strategy that ensures second-order accuracy, a numerical approximation of the Hodge projection, and a second-order discretization of the nonlinear convection terms. The basic requirements for second-order temporal accuracy are discussed in a semi-discrete form. Approximation of the projection using a discrete Galerkin formulation based on determination of a local basis for discretely divergence free vector fields is described. A specialized, second-order Godunov procedure is developed for discretization of the nonlinear convective terms. The Godunov method remains stable and non-oscillatory as Reynolds number tends to infinity. From a linear algebraic point of view the overall algorithm requires only the solution of symmetric, positive-definite systems that are ideally suited to iterative methods. Numerical results are presented validating the convergence properties of the method. DOE

N87-24648# Southwest Research Inst., San Antonio, Tex.
EXPERIMENTS ON DENSELY-LOADED NON-NEWTONIAN SLURRIES IN LAMINAR AND TURBULENT PIPE FLOWS Quarterly Technical Progress Report
R. J. Mannheimer, T. A. Grimley, J. T. Park, and T. B. Morrow 30 Apr. 1987 24 p
(Contract DE-FG22-86PC-90962)
(DE87-008934; DOE/PC-90962/T2; QTPR-2) Avail: NTIS HC A02/MF A01

The structure of non-Newtonian slurries in laminar, transitional, and turbulent flow regimes in pipes is studied. Experiments are conducted in a large-scale pipe slurry flow facility with an inside pipe diameter of 51 mm. Flow measurements including turbulence quantities such as Reynolds stress are taken with a two-component laser-Doppler velocimeter in a transparent test section with a transparent model slurry. Two transparent model slurries have been developed with non-Newtonian rheological properties. Silica gel particles with diameters on the order of one micron are suspended in two different hydrocarbon liquid mixtures with viscosities of 1.19 and 6.39 cS. In rheological measurements with a concentric cylinder viscometer, slurries from both liquid mixtures exhibited slip. From a linear regression analysis with a power-law model, slurries with the higher viscosity fluid had yield values of 80 and 30 dyn/sq cm for silica gel concentrations of 5.6 and 4.0% by weight, respectively, and the exponents were 0.584 and 0.763. The measured refractive index for the transparent slurries is 1.454 where the difference in refractive index between the fluid and silica gel is estimated to be less than 0.001. Bench scale tests with large diameter silica gel particles on the order of 100 microns have produced slurries with excessive turbidity. A silica gel manufactured by a different process which may form a less turbid slurry is currently under investigation. DOE

N87-24649# Illinois Inst. of Tech., Chicago. Dept. of Chemical Engineering.
EXPERIMENTAL GAS-SOLID VERTICAL TRANSPORT Ph.D. Thesis
Kuo Ming Luo May 1987 233 p
(Contract DE-FG22-84PC-70057)

(DE87-009082; DOE/PC-70057/T9) Avail: NTIS HC A11/MF A01

Gas-solid transport in dilute and dense phase conveying is studied. A new experimental system for vertical pneumatic conveying incorporates a screw feeder for dilute transport and an L-valve for dense flow. For measuring solid volume fractions a novel method using an x-ray densitometer was developed. The pressure in the system was measured using a strip chart recorder (SCR) and a manometer. The solids flux was estimated by collecting the particles from the system for a known time. The porosity and pressure drop data in the fully developed region were translated into drag coefficients and friction factors. The drag coefficients are in reasonable agreement with literature values. The friction factors with the wall were sometimes negative, reflecting downward flow, as observed in two-dimensional studies. Four available hydrodynamic models for vertical pneumatic conveying were used to predict the porosity and the pressure for the experimental conditions. Experimental data for porosity and pressure agree well with theoretical predictions. However, the predictions from the relative velocity model were in the best agreement for pressure drop values. DOE

N87-24650# Oak Ridge National Lab., Tenn.
IDEAL FLUID PROPERTIES FOR OPTIMIZING ABSORPTION HEAT PUMP PERFORMANCE
H. Perez-Blanco, M. R. Patterson, and J. Braunstein Apr. 1987 48 p
(Contract DE-AC05-84OR-21400)
(DE87-009777; ORNL/TM-10315) Avail: NTIS HC A03/MF A01

This report focuses on defining the fluid properties that will optimize the performance of a heat pump cycle. A simple heat pump computer model in conjunction with a parametric binary solution model is coupled to a computer code that searches for optimum values. The code determines the values of the parameters that maximize the thermal performance of the heat pump. The set of parameters is thermodynamically consistent. This set describes an ideal fluid with which single-effect cycle performance of 90% of Carnot is possible. The ideal fluid properties are a guide toward the properties that real fluids must exhibit in order to enhance the thermal performance of single-effect cycles. DOE

N87-24651 Harvard Univ., Cambridge, Mass.
STUDY OF BOUNDARY LAYER STRUCTURE USING LASER DOPPLER VELOCIMETRY, CONDITIONAL SAMPLING AND POLYMER ADDITIVES Ph.D. Thesis
Baha Engin Arik 1986 240 p
Avail: Univ. Microfilms Order No. DA8704387

The results of an investigation of the boundary layer structure on a free-surface water table are presented. Two-dimensional laminar flows as well as turbulent flows are achievable up to Reynolds number of 8,900. Strain rates and flow depth can be varied independently of the Reynolds number. Flow thicknesses in the range of 100 to 500 v/u sub tau (viscous wall units) can be obtained. Laminar mean velocity profiles measured using small scattering volume (SSV) laser Doppler velocimetry (LDV) agree well with calculations, hot film, and selective seeding LDV measurements, thus validating the uniform seeding SSV LDV. Average bursting frequencies were measured using the Variable Interval Time Averaging (VITA) technique on the u-velocity signal form SSV LDV, and two different length hot film probes. The results are in good qualitative agreement with each other, and the results of other investigations. Finally, a technique for flow diagnostics using the mean of the normalized local variance signals was developed. This flow indicator technique shows laminarization in the near wall region of drag reducing polymer flows, and can be used in boundary layers unambiguously to indicate whether they are laminar, turbulent, or drag reducing. Dissert. Abstr.

N87-24652 Arizona Univ., Tucson.
THE UNSTEADY VISCOUS FLOW OVER A GROOVED WALL: A COMPARISON OF TWO NUMERICAL METHODS Ph.D. Thesis
Shi-Chang Hung 1986 197 p
Avail: Univ. Microfilms Order No. DA8704773

Unsteady two-dimensional laminar flow of an incompressible viscous fluid over a periodically grooved wall is investigated by numerical simulations using two independent finite-difference methods. One is the vorticity-stream function method, and the other involves the vorticity-velocity induction law formulation. The flow field, which includes the time development of the shear layer and the recirculating flow in the zone of separation, is examined in detail during the transient phase to the steady-state condition. Characteristics of the transient solution for a moderate Reynolds number in the laminar range are presented. Included with the graphical results are the temporal development of the constant stream function contours, including the dividing contour between the zone of separation, and the main flow, and the constant vorticity contours. Comparisons obtained by the two numerical methods are made during the major development of the flow. The results showing the general features of the flow development including the time development of the shear layer, free shear layer, and recirculating flow are in good agreement. Dissert. Abstr.

N87-24653 California Univ., Santa Barbara.
CREEPING FLOW OF A SHEAR-THINNING FLUID PAST A SPEHERICAL VAPOR CAVITY Ph.D. Thesis
Faisal Abdullatif Jamjoom 1986 131 p
Avail: Univ. Microfilms Order No. DA8703655

An analytical expression for the stream function of a creeping flow of a shear-thinning fluid past a spherical vapor cavity is obtained using a consistent perturbation approach. The solution is carried out to include second order terms in the perturbation parameter lambda(=(n-1)/2)n being the flow index. The drag force of the vapor cavity is found also, and the results are compared to the first order expressions available in the literature. Agreement of terms up to the first order of lambda with available results is confirmed. A comparison is also made to existing experimental results. Dissert. Abstr.

N87-24654 California Inst. of Tech., Pasadena.
TRANSIENT GAS JETS INTO LIQUID Ph.D. Thesis
Jane Ming-Chin Lin 1987 129 p
Avail: Univ. Microfilms Order No. DA8702499

An experimental investigation of the development of high velocity, impulsively initiated gas jets into liquid was conducted in an effort to understand some of the physical processes that occur for a jet of very light fluid into a dense ambient atmosphere. Four gases, refrigerants 12 and 22, nitrogen, and helium were injected into water at nozzle exit Mach numbers from 1.0 to 2.2. It was shown that a gas jet into water develops in at least three stages: startup, transition, and global steady state. However, it was found that under some conditions, the gas jet into liquid never reaches the global steady state. Instead, the jet boundary exhibits chugging: large nonlinear oscillations which lead to irregular collapse. The conditions under which chugging occurs were determined experimentally. A quantitative measure of jet susceptibility to unsteadiness was established. The amplitude and frequency of chugging were found to be strongly dependent on the ratio of the liquid density to the gas density, the Mach number, and the operating pressure ratio. A model for chugging is presented. The stages of jet development and chugging were documented by pressure measurements and photography. Dissert. Abstr.

N87-24655 Polytechnic Univ., Brooklyn, N.Y.
ACCELERATION TECHNIQUES FOR THE SOLUTION OF THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS Ph.D. Thesis
George Chris Vradis 1987 102 p
Avail: Univ. Microfilms Order No. DA8704987

Described is a new technique for the solution of the steady state incompressible Navier-Stokes equations. The formulation is

in terms of primitive variables, is second-order accurate and is based on a two-stage pressure correction scheme which leads to extremely rapid convergence of all variables. It offers a reduction in computer time by a factor of two to six compared to previously published methods. The computational algorithm is based on a line-by-line sweep of the computational grid. Along each line the governing discretized equations are solved simultaneously using an efficient block tridiagonal algorithm. The method has been tested for both internal and external flow problems and has proven to be both accurate and fast. The new pressure correction technique has been applied to the solution of both the parabolized and the full form of the Navier-Stokes equations with dramatic reductions in computer time for both forms of the equations. The method is applied to laminar, two-dimensional flows but it is directly extendable to both turbulent and three-dimensional computations. Dissert. Abstr.

N87-24656# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de l'Aerodynamique.
FINITE DIFFERENCE METHODS TO COMPUTE IN DIRECT AND INVERSE MODES THE BOUNDARY LAYER OVER AN ARBITRARY OBSTACLE [METHODES AUX DIFFERENCES FINIES POUR LE CALCUL EN MODES DIRECT ET INVERSE DE LA COUCHE LIMITE SUR UN OBSTACLE QUELCONQUE]
D. Barberis Jan. 1986 130 p In FRENCH
(ONERA-RT-15/7252-AN-030-A; ETN-87-99620) Avail: NTIS HC A07/MF A01

A numerical method to solve the equations of boundary layers in three dimensional incompressible flow over obstacles of arbitrary shape is presented. Solutions are given for cases of known fluid velocities or known layer width. Applications show the possibility to compute fully three dimensional configurations, even after the flow separation line. ESA

N87-24657# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
FINITE ELEMENT DYNAMIC MODEL OF AN ELASTOACOUSTIC BEAM IN THE PRESENCE OF FLUID FLOW AND VISCOSITY Final Report [MODELE DYNAMIQUE PAR ELEMENTS FINIS D'UNE POUTRE ELASTO-ACOUSTIQUE EN PRESENCE D'ECOULEMENT ET DE VISCOSITE]
N. Piet Aug. 1986 63 p In FRENCH
(Contract CNES-84-3008)
(ONERA-RT-3/3596-RY-050-R; ETN-87-99624) Avail: NTIS HC A04/MF A01

The low frequency harmonic behavior of a fluid-structure coupled system is studied. The system is composed by an elastic pipe filled with a flowing viscous fluid. The finite element model is established using variational principles. A computer program was also developed to allow the modeling of such a system as a superelement for each Laplace variable. Applications to nuclear engineering problems are discussed. ESA

N87-24658# Ecole Polytechnique, Palaiseau (France).
NUMERICAL SOLUTION OF TRANSONIC THREE DIMENSIONAL STATIONARY COMPRESSIBLE FLOW EQUATIONS Final Report [RESOLUTION NUMERIQUE DES EQUATIONS D'ECOULEMENTS COMPRESSIBLES TRANSSONIQUES TRIDIMENSIONNELS STATIONNAIRES]
J. M. Dupuy and L. Aitaly Jul. 1986 47 p In FRENCH
(Contract DRET-83-434)
(ETN-87-99625) Avail: NTIS HC A03/MF A01

Variational principles are used to study flow around an aircraft wing. A fixed point technique is introduced to treat the nonlinearity of the problem and a concept of delayed density is used to account for the hyperbolic nature of the equations in the supersonic regime. The elliptical problem is solved using either scalar or vector potentials, and the results of both methods are compared. The presented finite element method works in potential transonic cases, does not require a nonvorticity hypothesis, and the results are comparable to classic methods. ESA

N87-24659# Institut Franco-Allemand de Recherches, St. Louis (France).
DIRECT MONTE-CARLO SIMULATION TECHNIQUE APPLIED TO SOME RAREFIED GAS DYNAMIC PROBLEMS
F. Seiler, B. Schmidt, and N. Kuschenrus 26 May 1986 14 p Presented at the 15th International Symposium on Rarefied Gas Dynamics, Grado, Italy, 16-20 Jun. 1986
(ISL-CO-217/86; ETN-87-99637) Avail: NTIS HC A02/MF A01

Direct Monte-Carlo simulation and experimental results are presented for: (a) the shock structure near a wall (b) shock reflection from a wedge and (c) a free expanding jet flow. The real gas flow was simulated statistically in two dimensions by using a large number of model molecules, following their positions in phase space. The incident shock wave of the flow pattern (a) and (b) was generated by a piston moving at constant velocity. In the shock region close to a wall, a boundary layer develops, which influences the shock structure. By an oblique shock reflexion from a wedge, a reflected shock wave forms. The influence of the wedge boundary layer on the reflected shock angle, the triple-point trajectory angle and the transition of Mach reflection are discussed. For determining the flow structure of an expanding jet, the outflow region was simulated with a computational model, beginning with critical gas conditions. ESA

N87-24660# Institut Franco-Allemand de Recherches, St. Louis (France).
DIRECT MONTE-CARLO CALCULATIONS ON EXPANSION WAVE STRUCTURE
F. Seiler 30 May 1986 14 p Presented at the 15th International Symposium Rarefied Gas Dynamics, Grado, Italy, 16-20 Jun. 1986
(ISL-CO-218/86; ETN-87-99638) Avail: NTIS HC A02/MF A01

The structure of a centered rarefactional wave was investigated using gas kinetic direct Monte-Carlo simulation in comparison with an isentropic continuum solution given by the method of characteristics. In the simulation study the real gas flow is modeled at atomic level for a monatomic, perfect gas with three degress of freedom. For one-dimensional computation, a piston generated the wave. Calculations were carried out for piston Mach numbers from 0.25 to 4. Monte-Carlo calculations show the expected continuous expansion wave structure which can not be given by the method of characteristics. An interesting phenomenon develops when the piston speed exceeds the maximum possible flow velocity. The calculation shows the particle free region closely behind the piston, as predicted by the continuum solution. In this case the flow velocity agrees well with the continuum theory. ESA

N87-24661# Institut Franco-Allemand de Recherches, St. Louis (France).
DOPPLER IMAGES OF VELOCITY FIELDS: AN APPLICATION TO FLUID DYNAMICS
F. Seiler and J. Srulijes 9 Jun. 1986 9 p Presented at the 3rd International Symposium on Applications of Laser Anemometry to Fluid Mechanics, Lisbon, Portugal, 7-9 Jul. 1986
(ISL-CO-220/86; ETN-87-99640) Avail: NTIS HC A02/MF A01

Continuous and pulsed lasers were used for Doppler imaging of steady and unsteady flow fields, with long and short exposure times. By using pulsed lasers for illumination, it is possible to investigate flow phenomena which cannot be investigated with usual laser velocimetry, at low cost. Lower precision is a disadvantage, but for many flow investigations, the possibility of obtaining velocity information about an entire plane cutting the flow field is much more important than the precision itself. It may be possible to increase the accuracy of the evaluation of Doppler-pictures by increasing the frequency sensitivity with the use of longer glass blocks, and by increasing the contrast of the Doppler-pictures to determine the fringe shift with greater precision. The use of an optical densitometer is recommended for ascertaining the light density variations occurring on the Doppler-picture. ESA

N87-24662# Institut Franco-Allemand de Recherches, St. Louis (France).
SIMULTANEOUS 3D LASER DOPPLER VELOCIMETER (LDV) MEASUREMENTS IN THE WAKE OF BLUFF BODIES
C. Berner 31 Jul. 1986 11 p Presented at the 3rd International Symposium on Applications of Laser Anemometry to Fluid Mechanics, Lisbon, Portugal, 7-9 Jul. 1986
(ISL-CO-224/86; ETN-87-99641) Avail: NTIS HC A02/MF A01

Turbulence fluctuations were measured in the near and far wake of a nonaxisymmetric blunt afterbody by a 3D, 3 color laser Doppler velocimeter. Results show that this velocimeter is operational and capable of measuring small velocities compared to the freestream velocity. Data obtained behind an afterbody including a triangular base show that this system can provide information of flowfields of three-dimensional nature. However, since there is an increase in the amount of information in 3D flow, further data reduction and complementary analysis are needed to reconstruct the entire velocity field and to clarify the different accuracy of the velocity components, especially in order to explain the difference of turbulence level observed at the stations where z is different from zero. ESA

N87-24663# Technische Univ., Munich (West Germany). Lehrstuhl fuer Stroemungsmechanik.
SOLUTION OF TRANSPORT EQUATIONS IN ARBITRARY REGIONS (STAR): A PROGRAM SYSTEM FOR THE CALCULATION OF THREE DIMENSIONAL FLOWS [STAR - EIN PROGRAMMSYSTEM ZUR BERECHNUNG DREIDIMENSIONALER STROEMUNGEN]
F. Baetke 21 Dec. 1984 51 p In GERMAN
(TUM-LSM-84/10; ETN-87-99646) Avail: NTIS HC A04/MF A01

The program system solution of Transport Equations in Arbitrary Regions for the solution of three-dimensional unsteady transport equations for a density-stable fluid, allowing a flexible choice of the geometry of the domain of computation within a Cartesian mesh, was developed. The transport equations for mass, momentum, turbulence energy, and turbulent dissipation were discretized and integrated. For the mesh, an index notation was introduced which enables a characterization of the geometrical and physical quantities. The determination of the convective and diffusive fluxes through the cell boundaries is reduced to simple, completely vectorizable weighting functions for the classical three-point difference methods as well as for a five-point method. A method for the automatic consideration of boundary conditions in laminar and turbulent flows, based on a harmonic interpolation method, is described. ESA

N87-24664# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
TEMPERATURE MEASUREMENT IN SPHERICALLY CONVEYING DETONATION WAVES. EXPERIMENTAL RESULTS WITH AN 800 MM APPARATUS [TEMPERATURMESSUNG IN SPHAERISCH KONVERGIERENDEN DETONATIONSWELLEN. EXPERIMENTELLE ERGEBNISSE IN DER 800 MM-APPARATUR]
Kunio Terao Dec. 1985 17 p In GERMAN
(MPIS-26/1985; ISSN-0436-1199; ETN-87-99705) Avail: NTIS HC A02/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 12

The gas temperature in spherically converging detonation waves in a stoichiometric propane-oxygen mixture in a hemisphere of inner diameter 800 mm was spectroscopically investigated. For the temperature measurement 5% Ar was added to the mixture and the intensity of Ar lines was determined as a function of time. The measured peak temperature behind the detonation front shows the same radial dependence on the radius as the pressure. The specific gas volume behind the detonation front within a radius of 40 mm, estimated from the measured temperatures and pressures, is always larger than that calculated from the Hugoniot equation at the same pressure. ESA

N87-24665# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
CAVITATION FLOW THROUGH A ROTATING PIPE [KAVITIERENDE STROEMUNG DURCH EIN ROTIERENDES ROHR]
A. Szumowski, A. Laake, and G. E. A. Meier Jul. 1986 35 p In GERMAN
(MPIS-9/1986; ISSN-0436-1199; ETN-87-99708) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 15

A one-dimensional cavitation flow (without Coriolis accelaration) in a rotating pipe was investigated with a view to cooling of gas turbine blades and compressors. This flow becomes unsteady and oscillates. Thereby, and unsteady cavitation domain is produced, separating the two partial water columns. At increasing rotation speed the oscillation frequency decreases and the extension of the cavitation domain increases. Above a critical rotation speed the water column is pressed out of the pipe, and the cavitation domain disappears. The flow computation was performed using the Runge-Kutta method for an incompressible model, and the characteristics method for a compressible model. The results of the calculations are supported by experimental results. ESA

N87-24666# Physikalisch-Technische Bundesanstalt, Brunswick (West Germany). Abteilung Waerme.
INVESTIGATIONS OF THE EVOLUTION OF TURBULENT GAS EXPLOSIONS [UNTERSUCHUNGEN ZUM ABLAUF TURBULENTER GASEXPLOSIONEN]
H. Foerster and H. Steen Oct. 1986 36 p In GERMAN
(PTB-W-32; ISBN-3-88-314-565-3; ISSN-0341-6739; ETN-87-99714) Avail: NTIS HC A03/MF A01

The explosion in turbulent stochiometric propane-air mixtures was investigated as a contribution to the safety evaluation of explosions. The effect of the turbulence parameters (average fluctuation velocity u' and average vortex ball diameter L) on the damage-effect-determining flame velocity were studied. Tests show that L is determined by the size of the turbulence field and by the geometry at the boundaries. An almost linear increase of vt as a function of u' (at fixed L) is found for the experimentally accessible turbulence intensities. Contrary to simple model expectations, a significant increase of vt as a function of L (at fixed u') is also found. Therefore, u' as well as L have to be considered in the safety evaluation. Tests show that the maximum explosion pressure increase is not only determined by the turbulence state of the mixture, but also by apparatus factors such as container size and geometry as well as the type of turbulence excitation. ESA

N87-24667# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
THREE-DIMENSIONAL INVISCID TURBOMACHINERY FLOW SIMULATIONS OBTAINED BY SOLVING THE EULER EQUATIONS ON AN O-H TYPE GRID
Bjoern Krouthen 17 Dec. 1986 36 p Sponsored by the Swedish Board for Technical Development, and the Swedish Aero Engine Co.
(FFA-TN-1986-77; ETN-87-99783) Avail: NTIS HC A03/MF A01

A computer code for calculating the steady inviscid flow in a rotating system (turbomachinery) by solving the 3-dimensional Euler equations on an O-H type grid is developed. The numerical method is an explicit, centered finite-volume scheme. The method includes an artificial viscosity model and a local time step technique. The explicit time integration scheme is a one-step, three-stage Runge-Kutta method. The generation of the grid is done by transfinite interpolation. The grid used has an O-H type structure which gives good resolution at the leading and trailing edges. Different geometries were used under different flow conditions. Results for three different turbine blades are presented. Comparisons between experimental data and other Euler solvers show the accuracy of the code. ESA

N87-24668# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies

ANALYTICAL, NUMERICAL, AND EXPERIMENTAL INVESTIGATIONS OF OBLIQUE-SHOCK-WAVE REFLECTIONS IN PURE AND DUSTY GASES Final Report, 1 Feb. 1982 - 31 Jan. 1987

I. I. Glass Feb. 1987 24 p
(Grant AF-AFOSR-0096-82)
(AD-A179715; AFOSR-87-0394TR) Avail: NTIS HC A02/MF A01 CSCL 20D

A summary is given of the research which was accomplished during the past five years (Feb. 1, 1982 to Jan. 31, 1987) on USAF Grant AFOSR-82-0096. Numerous journal papers and reports have been published including the Dryden Lecture by Prof. I. I. Glass on Some Aspects of Shock Wave Research , which appeared in the AIAA Journal, 25, 2, pp. 214-229, 1987. It is shown that many important contributions have been made interferometrically, analytical and numerically to nonstationary oblique shock-wave reflections, which have achieved international recognition. Although the anayticaly and numerical foundations have been laid for dusty gas shock tube flows, the experimental work has not kept pace, owing to the difficulty of getting homogeneous air dust mixtures. It is a very difficult problem, which we hope to resolve in 1987. GRA

N87-24669# Arizona Univ., Tucson. Engineering Experiment Station.

EXPERIMENTAL AND NUMERICAL INVESTIGATION OF COHERENT STRUCTURES IN TURBULENT WAKE FLOWS Annual Report, 5 Feb. 1986 - 4 Feb. 1987

F. H. Champagne and H. Fasel 7 Apr. 1987 19 p
(Grant AF-AFOSR-0146-85)
(AD-A179720; AFOSR-87-0544TR) Avail: NTIS HC A02/MF A01 CSCL 01A

Recent x wire measurements in a plane turbulent wake are presented. Sinuous disturbances at several amplitudes and frequencies were introduced to the wake by oscillating a small trailing edge flap. The Strouhal numbers of the perturbations were specially chosen so that the downstream location of the neutral point (where the spatial amplification rate obtained from linear stability theory vanishes) was well within the range of measurements. The stream wise variation of the half width of the wake and the centerline velocity deficit was dependent on the amplitude level and showed dramatic deviations at large forcing levels from the well-known square root behavior of the unforced case. The measured coherent Reynolds stressed were observed to change sign in the neighborhood of the location of the neutral point as predicted by linear viscous theory. The numerical simulations of free shear layers and progress towards the wake simulations are also discussed. GRA

N87-24670# New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.

TEMPERATURE FIELD IN THE VICINITY OF A NEAR-SURFACE VOID DUE TO HIGH-SPEED FRICTION LOAD

Frederick D. Ju and Tsu-Yen Chen Feb. 1987 49 p
(Contract N00014-84-K-0252)
(AD-A180013; ME-140(86)ONR-233-3) Avail: NTIS HC A03/MF A01 CSCL 20M

The present investigation expound on the effect of a near-surface cavity, when the solid surface is subjected to the Coulomb frictional loading of an asperity moving at moderately high-speed. The medium under consideration is represented by a solid half space which is coated with a thin layer of solid wear coating. The cavity in the present report is rectangular. The temperature field and its gradient in the vicinity of the cavity result from the traverse of the asperity over the wear surface near the cavity. The cavity defect results in a material nonuniformity mathematically modelled in terms of the material coordinates. The resulting governing differential equation is time-explicit and transient. A general finite difference formulation is developed, from which numerical solutions were obtained for problems with a cavity at various positions relative to the surface-layer/substrate interface. Because of the poor heat transfer characteristics of the cavity, the temperatures in the surface layer above it are higher than those in the surrounding region. This phenomenon causes a higher temperature gradient, especially at the trailing corner of the rectangular cavity. GRA

N87-24671*# National Aeronautics and Space Administration, Washington, D.C.

THE FUNDAMENTALS OF TURBULENT HEAT TRANSFER

H. Reichardt Jun. 1987 38 p Transl. into ENGLISH from Archiv fuer die Gesamte Waermetechnik (West Germany), v. 6-7, 1951 p 129-143 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20028; NAS 1.77:20028) Avail: NTIS HC A03/MF A01 CSCL 20D

The literature on turbulent heat transfer has assumed considerable proportions in the course of the year. Since there is still no complete solution for this very complex problem, further studies in this field are to be expected. The heating engineer must therefore contend with a constantly increasing number of theories and formulae. Since the theories are usually based on hypothetical assumptions, and since they contain correct and erroneous statements, proven theories and pure assumptions often become confused with each other in a manner that is difficult to discern, even the specialist has difficulty in properly evaluating the individual studies. There is therefore a requirement for a depiction of the turbulent heat transfer which is not bound in advance by hypothetical conditions and which clearly distinguishes that which is already known from that which is not yet researched. Such a depiction is presented. Author

N87-24672*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

MULTISCALE TURBULENCE EFFECTS IN SUPERSONIC JETS EXHAUSTING INTO STILL AIR

Khaled S. Abdol-Hamid (Analytical Services and Materials, Inc., Hampton, Va.) and Richard G. Wilmoth Jul. 1987 38 p
(NASA-TP-2707; L-16258; NAS 1.60:2707) Avail: NTIS HC A03/MF A01 CSCL 20D

A modified version of the multiscale turbulence model of Hanjalic has been applied to the problem of supersonic jets exhausting into still air. In particular, the problem of shock-cell decay through turbulent interaction with the mixing layer has been studied for both mildly interacting and strongly resonant jet conditions. The modified Hanjalic model takes into account the nonequilibrium energy transfer between two different turbulent spectral scales. The turbulence model was incorporated into an existing shock-capturing, parabolized Navier-Stokes computational model in order to perform numerical experiments. The results show that the two-scale turbulence model provides significant improvement over one-scale models in the prediction of plume shock structure for underexpanded supersonic (Mach 2) and sonic (Mach 1) jets. For the supersonic jet, excellent agreement with experiment was obtained for the centerline shock-cell pressure decay up to 40 jet radii. For the sonic jet, the agreement with experiment was not so good, but the two-scale model still showed significant improvement over the one-scale model. It is shown that by relating some of the coefficients in the turbulent-transport equations to the relative time scale for transfer of energy between scales the two-scale model can provide predictions that bound the measured shock-cell decay rate for the sonic jet. Author

N87-24673*# National Aeronautics and Space Administration, Washington, D.C.

EXPERIMENTAL STUDIES ON THE STABILITY AND TRANSITION OF 3-DIMENSIONAL BOUNDARY LAYERS

P. Nitschke-Kowsky Jun. 1987 114 p Transl. into ENGLISH of Experimentelle Untersuchungen zu Stabilitaet und Umschlag dreidimensionaler Grenzschichten, DFVLR, 19 Jun. 1986 Original language document was previously announced as N87-14664 Transl. by The Corporate Word, Inc., Pittsburgh, Pa. Original document prepared by DFVLR, Goettingen (West Germany)

(NASA-TM-88539; NAS 1.15:88539; DFVLR-FB-86-24) Avail: NTIS HC A06/MF A01 CSCL 20D

Three-dimensional unstable boundary layers were investigated as to their characteristic instabilities, leading to turbulence. Standing cross-flow instabilities and traveling waves preceding the transition were visualized with the hydrogen bubble technique in the boundary layer above the wall of a swept cylinder. With the sublimation method and hot film technique, a model consisting of a swept flat plate with a pressure-inducing displacement body in the 1 m wind tunnel was studied. Standing waves and traveling waves in a broad frequency are observed. The boundary layer of this model is close to the assumptions of the theory. ESA

N87-24674*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NEAR-WALL k-EPSILON TURBULENCE MODELING

N. N. Mansour, J. Kim, and P. Moin Jun. 1987 24 p (NASA-TM-89461; A-87222; NAS 1.15:89461) Avail: NTIS HC A02/MF A01 CSCL 20D

The flow fields from a turbulent channel simulation are used to compute the budgets for the turbulent kinetic energy (k) and its dissipation rate (epsilon). Data from boundary layer simulations are used to analyze the dependence of the eddy-viscosity damping-function on the Reynolds number and the distance from the wall. The computed budgets are used to test existing near-wall turbulence models of the k-epsilon type. It was found that the turbulent transport models should be modified in the vicinity of the wall. It was also found that existing models for the different terms in the epsilon-budget are adequate in the region from the wall, but need modification near the wall. The channel flow is computed using a k-epsilon model with an eddy-viscosity damping function from the data and no damping functions in the epsilon-equation. These computations show that the k-profile can be adequately predicted, but to correctly predict the epsilon-profile, damping functions in the epsilon-equation are needed. Author

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

N87-24675# European Space Agency, Paris (France).

DIGITAL DATA RECORDING ON FLOPPY DISKS APPLIED FOR ONBOARD USE IN HELICOPTERS

Rainer Holland, Horst Meyer, and Peter Pfleging Dec. 1986 38 p Transl. into ENGLISH of "Diskettenregistrieung als Beispiel Digitaler Messdatenaufzeichnung an Bord von Hubschraubern" DFVLR, Brunswick (West Germany), May 1986 Original language document was previously announced as N87-11149 (ESA-TT-1011; DFVLR-Mitt-86-10; ETN-87-99853) Avail: NTIS HC A03/MF A01; original German version available from DFVLR, Cologne, West Germany DM 16.50

A direct data recording system for helicopter flight tests was developed. The system stores the flight test data in an onboard mass memory. It fulfills the requirements imposed by the high vibration level of helicopters, and by the limted space and weight possibilities. Hardware configuration, software, and terminal are described. The system can be easily built and used. Comparisons with analog data recording show an improvement of data quality. ESA

N87-24676# International Centre for Theoretical Physics, Trieste (Italy).

HOLOGRAPHIC FOUR-WAVE MIXING AS A STURM-LIOUVILLE PROBLEM

M. R. Belic Jul. 1986 12 p (DE87-701776; IC-86/101) Avail: NTIS (US Sales Only) HC A02/MF A01

The problem of a steady-state degenerate four-wave mixing in nonlinear dynamic media is reduced to a Sturm-Liouville or a one-dimensional quantum-mechanical scattering problem, which is treated exactly. Linear absorption in the medium is accounted for, and laser pump depletion is allowed. No restrictions are placed on the spatial mismatch between light interference fringes and refractive index gratings. Both energy and phase transfers are considered simultaneously. DOE

N87-24677 Paris-Sud Univ., Orsay (France).

A DEVICE FOR THE NUMERICAL TREATMENT OF MAGNETO OPTICAL IMAGES Ph.D. Thesis [DISPOSITIF POUR LE TRAITEMENT NUMERIQUE DES IMAGES MAGNETOOPTIQUES]

Tomasz Daniel 1985 79 p In FRENCH; ENGLISH summary Sponsored by CNES, Centre National des Etudes des Telecommunications, and the DAII (ETN-87-99561) Avail: NTIS Issuing Activity

A device which substracts nonmagnetic contrast of magneto-optical images is described. Noise is reduced to such a degree that the contrast visibility limit is expanded by at least an order of magnitude. The incoming video signal, sampled at 10 MHz and coded at 8 bits is stored in one of the three 512x512x8 image memories. A high speed arithmetic processor adds and substracts images, pixel by pixel, at 10 Mbytes/sec. The device is controlled by a 6809 microprocessor. The main mode of operation is to compare the image of a sample with magnetic domains with the image of the sample in a saturated state. The difference is accumulated to obtain the required noise reduction. Improvements of longitudinal Kerr effect images are shown. ESA

N87-24678# Institut Franco-Allemand de Recherches, St. Louis (France).

HOLOGRAPHIC CINEMATOGRAPHY AND ITS APPLICATIONS

P. Smigielski, H. Fagot, and F. Albe 20 Aug. 1986 10 p Presented at the International Conference on Holography Applications (ICHA) 86, Beijing, China, 2-4 Jul. 1981 (ISL-CO-227/86; ETN-87-99644) Avail: NTIS HC A02/MF A01

Recording of single-exposure cineholograms of living bodies on 126-mm films, at a repetition rate of 25 holograms per second with the help of a frequency-doubled pulse YAG-laser; and recording of double-exposure cineholograms of reflecting moving objects for medical and industrial applications are reported. Limitations of 3D movies are described. ESA

N87-24679# Max-Planck-Inst. fuer Physik und Astrophysik, Munich (West Germany). Inst fuer Extraterrestrische Physik.

DESIGN AND CONSTRUCTION OF A COELOSTAT FOR HETERODYNE MEASUREMENTS AT A WAVELENGTH OF 10 MICROMETER Thesis [ENTWURF UND BAU EINES COELOSTATEN FUER HETERODYNMESSUNGEN BEI 10 MIKROMETER WELLENLAENGE]

Rainer Strzoda Jan. 1987 79 p In GERMAN (MPE-199; ISSN-0178-0719; ETN-87-99649) Copyright Avail: NTIS HC A05/MF A01

A heliostat was designed and built as carrier for a 10 micrometer IR heterodyne spectrometer for transmission measurements in the Earth atmosphere for investigations of solar oscillations. The high wavelength resolution allows the determination of line profiles and transition frequencies with high precision. A series of highly resolved ozone absorption spectra lead to the vertical ozone distribution, in good agreement with reference measurements. An improvement of the results is expected after a more precise determination of ozone spectroscopic data from laboratory measurements. The measurement uncertainties are still too high to determine a frequency spectrum of solar oscillations. ESA

N87-24680# Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany). Bereich Datenverarbeitung und Elektronik.
RANDOM PULSE GENERATOR WITH AN EQUAL AMPLITUDE DISTRIBUTION
J. Lauch and H. U. Nachbar Jul. 1986 34 p In GERMAN; ENGLISH summary
(HMI-B-435; DE-167; ETN-87-99663) Avail: NTIS HC A03/MF A01

A random pulse generator with a white amplitude spectrum was developed for tuning procedures and control measurements in nuclear radiation measuring techniques. The pulse generator produces statistically distributed amplitudes and pulse distances. The amplitude range of the output pulses is between 0.1 and 10 V peak to peak; width is 2 microns. The pulse rate can be varied continuously from 0.1 to 10 kips. Distortions of the event spectrum can occur if random pulses are supplied to an analog-to-digital converter with a dead time depending on the pulse amplitude. These distortions are calculated and discussed. Problems which occurred during development, and the limitations of the generator are discussed. ESA

N87-24681*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPLICATION OF DIGITAL HOLOGRAPHIC INTERFEROMETRY TO PRESSURE MEASUREMENTS OF SYMMETRIC, SUPERCRITICAL AND CIRCULATION-CONTROL AIRFOILS IN TRANSONIC FLOW FIELDS
Francisco J. Torres Jun. 1987 23 p
(NASA-TM-88358; A-86402; NAS 1.15:88358) Avail: NTIS HC A02/MF A01 CSCL 20F

Six airfoil interferograms were evaluated using a semiautomatic image-processor system which digitizes, segments, and extracts the fringe coordinates along a polygonal line. The resulting fringe order function was converted into density and pressure distributions and a comparison was made with pressure transducer data at the same wind tunnel test conditions. Three airfoil shapes were used in the evaluation to test the capabilities of the image processor with a variety of flows. Symmetric, supercritical, and circulation-control airfoil interferograms provided fringe patterns with shocks, separated flows, and high-pressure regions for evaluation. Regions along the polygon line with very clear fringe patterns yielded results within 1% of transducer measurements, while poorer quality regions, particularly near the leading and trailing edges, yielded results that were not as good. Author

N87-24682*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
REAL-TIME SIMULATION CLOCK Patent Application
Donald R. Bennington, inventor (to NASA) and Daniel J. Crawford, inventor (to NASA) 5 Feb. 1987 12 p
(NASA-Case-LAR-13615-1; NAS 1.71:LAR-13615-1; US-Patent-Appl-SN-010949) Avail: NTIS HC A02/MF A01 CSCL 14B

A real time simulation clock is decribed for generating frame tics that synchronize computations to the real time and to other computations in a system that has a central computer and multiple remote sites that utilize the central computer. Timing tics are generated with a first time interval between successive tics. Job sync tics are generated with a second time interval between successive tics. The second time interval is an exact multiple of the first time interval. A preselected frame time for each site, the timing tics and the job tics are used to generate frame tics synchronized with the job tics. NASA

N87-24741# Stuttgart Univ. (West Germany).
IMPROVEMENT OF IMAGE QUALITY BY FORWARD MOTION COMPENSATION, A PRELIMINARY REPORT
Friedrich Ackermann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 25-32 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24743# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Section.
THOUGHTS ON A STANDARD ALGORITHM FOR CAMERA CALIBRATION
Hartmut Ziemann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 41-48 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24744# Xian Research Inst. of Surveying and Mapping (China).
APPLIED FORMULAE FOR CALIBRATION OF AERIAL PHOTOGRAMMETRIC CAMERAS
Wang Yuwei *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 49-54 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24745# Bonn Univ. (West Germany). Inst. of Photogrammetry.
GEOMETRICAL SYSTEM CALIBRATION, ESPECIALLY FOR METRIC AERIAL CAMERAS
G. Kupfer *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 55-62 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24749# Stuttgart Univ. (West Germany).
THE USE OF CAMERA ORIENTATION DATA IN PHOTOGRAMMETRY: A REVIEW
Friedrich Ackermann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 93-99 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24750# Stuttgart Univ. (West Germany).
THE EFFECTS OF CAMERA POSITION AND ATTITUDE DATA IN AERIAL TRIANGULATION, A SIMULATION STUDY
Peter Friess *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 101-111 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24757# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Div. of Physics.
PROPOSED CHANGES TO THE CANADIAN CAMERA CALIBRATION REPORT
H. Ziemann, M. L. Landreville, and J. E. W. Plummer *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 163-169 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24758# Munich FAF Univ., Neubiberg (West Germany).
INTERIOR ORIENTATION STABILITY OF A PARTIAL METRIC CAMERA, AN EXPERIMENTAL STUDY
J. Peipe *In its* Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 171-178 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24759# Joensuu Univ. (Finland). Dept. of Physics.
GONIOMETER FOR CALIBRATION OF SYSTEM AND OTHER SMALL CAMERAS
J. Hakkarainen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 179-184 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24760# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
ENVIRONMENTAL CONDITIONS AND CALIBRATION OF THE SPACELAB METRIC CAMERA
M. Schroeder *In* ESA Proceedings of the International Symposium

on Progress in Imaging Sensors Nov. 1986 p 185-190 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24772# Agfa-Gevaert N.V., Mortsel (Belgium). Graphic Systems Div.
THE AVIPHOT PAN 50 PE FILM
H. VandePoel and W. Liekens *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 288-293 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24773# Xian Research Inst. of Surveying and Mapping (China).
ON THE MATCHING OF RESOLUTION IN AERIAL PHOTOGRAPHIC SYSTEMS
Junliang Cai and Huiping Chen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 295-302 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24774# Institut Geographique National, Paris (France).
INSTITUT GEOGRAPHIQUE NATIONAL (IGN), FRANCE: PARTICIPATION IN SPACELAB PHOTOGRAPHIC TEST CAMPAIGN
R. Charton *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 303-309 (For primary document see N87-24738 18-43)
Avail: NTIS HC A99/MF A01

N87-24776# Firma Maps G.m.b.H., Munich (West Germany).
VERY HIGH RESOLUTION AERIAL FILMS
Rolf Becker *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 317-326 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24780# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Section.
THE ROLE OF GOVERNMENT SPECIFICATIONS IN AERIAL PHOTOGRAPHY
Hartmut Ziemann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 351-353 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24781# Zeiss (Carl), Oberkochen (West Germany).
THE RMK AERIAL CAMERA SYSTEM: PERFORMANCE POTENTIAL OF AERIAL PHOTOGRAPHY WITH FORWARD MOTION COMPENSATION
W. Lorch *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 363-366 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24782# Wild Heerbrugg Ltd. (Switzerland).
WILD AVIOPHOT (TM) RC20 AERIAL CAMERA SYSTEM. THE OTHER APPROACH TO IMAGE MOTION COMPENSATION IN AERIAL PHOTOGRAPHY
Arthur Rohrbach and Roland Schlienger *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 367-373 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24783# Hansa Luftbild G.m.b.H., Muenster (West Germany).
PRACTICAL EXPERIENCES WITH THE ZEISS FORWARD IMAGE MOTION COMPENSATION (FMC) SYSTEM
G. Winkelmann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 375-377 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24786# Stuttgart Univ. (West Germany). Inst. fuer Photogrammetrie.
CALIBRATION OF CCD VIDEO CAMERAS
E. Guelch *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 391-403 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24787# Karlsruhe Univ. (West Germany). Inst. of Photogrammetry and Topography.
EVALUATION OF A SOLID STATE CAMERA FOR PHOTOGRAMMETRIC APPLICATIONS
Joachim Wiesel and Thomas Voegtle *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 405-408 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24790# Technische Univ., Hanover (West Germany). Inst. of Photogrammetry and Engineering Surveys.
GEOMETRIC ASPECTS OF THE USE OF SPACE PHOTOGRAPHS
Karsten Jacobsen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 427-432 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24792# Ludwig-Maximilians-Universitaet, Munich (West Germany). Inst. fuer Geographie.
LARGE FORMAT CAMERA PHOTOGRAPHS OF THE BLACK HILLS, USA, AND THEIR SUITABILITY FOR TOPOGRAPHIC AND THEMATIC MAPPING
Klaur R. Dietz *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 439-448 In GERMAN; ENGLISH summary (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24793# International Inst. for Aerial Survey and Earth Sciences, Enschede (Netherlands).
ON THE EQUIVALENT PIXEL-SIZE AND MEANINGFUL BIT-NUMBER OF AIRPHOTOGRAPHS. OPTIMAL SCANNING APERTURE AND DENSITY INCREMENT FOR DIGITIZING AIR PHOTOGRAPHS
S. A. Hempenius and Jia-bin Xuan *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 451-464 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24794# Technische Univ., Hanover (West Germany). Inst. for Photogrammetry and Engineering Surveys.
DIGITIZATION OF METRIC CAMERA AND LARGE FORMAT CAMERA SPACE PHOTOGRAPHS
Peter Lohmann and Thomas Luhmann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 465-469 (For primary document see N87-24738 18-43)
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N87-24795# New South Wales Univ., Sydney (Australia). School of Surveying.
GEOMETRIC ASPECTS OF DIGITIZED PHOTOGRAPHY
J. C. Trinder *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 471-475 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24796# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
TRIPLE STEREOSCOPIC IMAGERY SIMULATION AND DIGITAL IMAGE CORRELATION FOR MONOCULAR ELECTRO-OPTICAL STEREO SCANNER (MEOSS) PROJECT
Manfred Lehner *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 477-484 Original document contains color illustrations (For primary document see N87-24738 18-43)
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primary document see N87-24738 18-43)
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N87-24798# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Div. of Physics.
SPECTROPHOTOMETRIC MEASUREMENTS ON COLOR AERIAL PHOTOGRAPHS
H. Ziemann, J. C. Croteau, J. R. Handy, and E. Nagy *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 491-503 (For primary document see N87-24738 18-43)
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N87-24799# Technische Univ., Vienna (Austria). Inst. fuer Vermessungswesen und Fernerkundung.
PHOTOGRAPHIC QUALITY OF COLOR IR AERIAL PHOTOS AS A FUNCTION OF ATMOSPHERIC PARAMETERS
W. Schneider *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 505-509 Sponsored by the Austrian Fonds zup Foerderung der Wissenschaftlichen Forschung (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24800# Jenoptik Jena G.m.b.H. (East Germany).
SOME PROBLEMS OF EXPOSURE METERING IN AERIAL PHOTOGRAPHY
Ulrich Zeth and Heinrich Klose *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 511-517 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24806# Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Photogrammetry.
DETERMINATION OF THE MODULATION TRANSFER FUNCTION FOR AERIAL CAMERAS UNDER FLIGHT CONDITIONS
Otto Koebl and Joseph Hawawini *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 565-572 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24807# Joensuu Univ. (Finland). Dept. of Physics.
RESOLVING POWER PROFILES AND AWAR OF NEW AERIAL CAMERAS
J. Hakkarainen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 573-579 (For primary document see N87-24738 18-43)
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N87-24814# Royal Inst. of Tech., Stockholm (Sweden). Dept. of Photogrammetry.
IMAGE QUALITY PROBLEMS IN PRACTICAL AERIAL PHOTOGRAPHY
Anders E. Boberg *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 627-634 (For primary document see N87-24738 18-43)
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36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N87-24683# Falcovitz (Joseph), Haifa (Israel).
TRANSIENT REACTIVE EXHAUST FLOW FROM A RING-SYMMETRIC HF/DF SPACE LASER Final Report, Jan. - Mar. 1987
Joseph Falcovitz and A. E. Fuhs Mar. 1987 53 p
(Contract N62271-86-M-0214)
(AD-A179208; NPS-72-87-002CR) Avail: NTIS HC A04/MF A01 CSCL 22B

Transient diffuser flow in an HF/DF laser is analyzed via a simplified model. A radial laser configuration is assumed where the diffuser is idealized as a ring-symmetric channel of uniform width. The outward radial flow following an abrupt start-up of diffuser inflow is computed numerically using a GRP-type code for integrating the Euler equations, which include an ongoing reaction of hydrogen recombination. A new kinetic scattering effect is suggested, resulting from the recoil of an HF or DF molecule assisting as third body in the hydrogen recombination reaction. The main conclusion is that transient diffuser plume flow effects do not drastically aggravate the potential for contaminating backflow (HF + DF) caused by either thermal or kinetic backscattering. GRA

N87-24684# Los Alamos National Lab., N. Mex.
A SINGLE-PASS FREE-ELECTRON LASER FOR SOFT X-RAYS WITH WAVELENGTHS LESS THAN OR EQUAL TO 10 nm
J. C. Goldstein, T. F. Wang, B. E. Newnam, and B. D. McVey 1987 4 p Presented at the Particle Accelerator Conference, Washington, D.C., 16 Mar. 1987
(Contract W-7405-eng-36)
(DE87-007482; LA-UR-87-921; CONF-870302-33) Avail: NTIS HC A02

We consider a single-pass FEL amplifier, driven by an rf-linac followed by a damping ring for reduced emittance, for use in generating intense coherent light at wavelengths less than 10 nm. The dependence of the optical gain on electron beam quality, studied with the 3-D FEL simulation code FELEX, is given and related to the expected power of self-amplified spontaneous emission. Design issues for the damping ring to achieve the required electron beam quality are discussed. DOE

N87-24685# Los Alamos National Lab., N. Mex.
THE LOS ALAMOS FREE-ELECTRON LASER ENERGY-RECOVERY EXPERIMENT
D. W. Feldman, R. W. Warren, J. M. Watson, W. E. Stein, J. S. Fraser, G. Spalek, A. H. Lumpkin, B. E. Carlsten, H. Takeda, T. F. Wang et al. 1987 4 p Presented at the Particle Accelerator Conference, Washington, D.C., 16-19 Mar. 1987
(Contract W-7405-eng-36)
(DE87-007463; LA-UR-87-633; CONF-870302-42) Avail: NTIS HC A02/MF A01

Experiments have been concluded demonstrating energy recovery in conjuction with the Los Alamos free-electron laser. Measurements of electron-beam transport during decelerations greater than 70% from 21 MeV down to 5 MeV are discussed. Power flow measurements demonstrate the efficient conversion of beam power back into rf power and its reuse in the accelerator. Instabilities of the system are also described and compared with simulations. DOE

N87-24686# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
NITROGEN LASER FOR STREAMER CHAMBER ILLUMINATION
Hye Sok Ban, V. I. Lyashenko, Ding Lok Nguyen, Eh. Sodnomyn, T. Tudor, and Yu. A. Sncherbakov 1986 6 p In RUSSIAN; ENGLISH summary
(DE87-701710; JINR-R-15-86-146) Avail: NTIS (US Sales Only) HC A02/MF A01

To illuminate the Dubna 650x450x150 mm streamer chamber a laser with increased power is required. For this purpose a high-power ultraviolet nitrogen laser has been constructed using inductionless ceramic capacitors. The volume of its discharge tube and the capacity of storage capacitors as well as the supply voltage are increased. The peak power achieved is 0.6 MW within the 36 cu cm active volume for 5 ns pulse duration at midheight. The laser construction and the performances are presented. DOE

N87-24687# Yale Univ., New Haven, Conn. Dept. of Applied Physics.
INVESTIGATION OF SUPERRADIANT LDV MARKERS AND THREE-COMPONENT VELOCITY MAPPING Annual Report, 1 Jan. - 31 Dec. 1986
Richard K. Chang 30 Jan. 1987 14 p
(Contract F49620-85-K-0002)
(AD-A179732; AFOSR-87-0564TR) Avail: NTIS HC A02/MF A01 CSCL 09C

Consider high intensity laser beam interactions with single transparent micrometer size droplets flowing in the linear stream applied to real time diagnostics of the chemical species contained within droplets of sprays. Research efforts are directed toward exploring the limits of high intensity irradiation of micrometer size transparent droplets. Two effects are considered: (1) the intensity dependent index of refraction of the liquid, which can lead to self focusing of the laser beam within the droplet and to broadening of the Raman radiation and elastic scattering due to phase modulation within the droplet; and (2) laser induced dielectric breakdown, which can occur either in the gas surrounding the droplet or in the liquid within the droplet. The breakdown generates a shock wave and/or an optical detonation wave which causes material to stream from the droplet and form plumes. Success was achieved in developing an optical technique with potential of proving three component velocity mapping in three dimensions. A time coded five pulse volume holography of silver coated hollow spheres seeded in a cold flow has been recorded, and an automated pattern recognition technique (Hough transform) has been adapted to identify straight lines formed by the five exposures of the same silver coated particles, which were sparsely seeded in a nozzle flow. GRA

N87-24688# Naval Research Lab., Washington, D. C.
MODIFICATION OF ELECTRON CYCLOTRON MASER OPERATION BY APPLICATION OF AN EXTERNAL SIGNAL Final Report
Alan H. McCurdy, C. M. Armstrong, and W. M. Bollen 31 Mar. 1987 32 p
(AD-A179999; NRL-9038) Avail: NTIS HC A03/MF A01 CSCL 09C

Operation of the electron cyclotron resonance maser (ECRM) when subjected to an external rf signal is studied. The signal is introduced both by direct injection through a coupling hole in the oscillator and by modulating the electron beam in separate cavities, upstream of the oscillator. Experiments using both one and two pre bunching cavities are reported. It is found that the gyromonotron, a specific embodiment of the ECRM, can be phase locked by premodulating the electron beam. In this case, the required drive power levels are more than 15 dB below that predicated by Adler's widely applicable theory for single-cavity oscillators. In addition, the same method allows oscillator phase-locked systems, significant reduction of frequency and amplitude noise is observed within the locking band. In signal of a power level 65 dB below that of the oscillator. The general amplitude and frequency response of the ECRM to an applied external signal is also investigated. Three distinct regions of qualitatively different behavior are noted: soft excitation, which is free, self excited oscillation; hard excitation, where the oscillation requires an external impulse for start up; and amplifier, in which the output power level and frequency are linearly related to the drive in the small regime. GRA

N87-24732# Joint Publications Research Service, Arlington, Va.
NEW MODEL He-Ne LASER TUBES TESTED
Yuzhi Wang and Zonglin Huang *In its* China Report: Science and Technologt 2 May 1986 p 56-64 Transl. into ENGLISH from Dianzi Xuebao (Beijing, China), v. 13, no. 4, Jul. 1985 p 50-56 (For primary document see N87-24729 18-42)
Avail: NTIS HC A05/MF A01

N87-24963# Joint Publications Research Service, Arlington, Va.
HIGH-POWER TUNABLE ALEXANDRITE LASER WITH GIANT PULSE OUTPUT, SHG
Bangxing Zhang, Lusheng Wu, Meirong Zhao, and Haili Zhang *In its* China Report: Science and Technology 2 Sep. 1986 p 64-69 Transl. into ENGLISH from Guangxue Xuebao (Shanghai, China), v. 6, no. 5, May 1986 p 408-412 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N87-24689* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
REMOTELY CONTROLLED SPRAY GUN Patent
William C. Cunningham, inventor (to NASA) (Martin Marietta Corp., Huntsville, Ala.) 19 May 1987 5 p
(NASA-Case-MFS-28110-1; US-Patent-4,666,086; US-Patent-Appl-SN-852466; US-Patent-Class-239-433; US-Patent-Class-239-596; US-Patent-Class-239-600) Avail: US Patent and Trademark Office CSCL 13I

A remotely controlled spray gun is described in which a nozzle and orifice plate are held in precise axial alignment by an alignment member, which in turn is held in alignment with the general outlet of the spray gun by insert. By this arrangement, the precise repeatability of spray patterns is insured.
Official Gazette of the U.S. Patent and Trademark Office

N87-24690# Hughes Aircraft Co., El Segundo, Calif. Electro-Optical and Data Systems Group.
COMPUTER SIMULATION OF BALL BEARING DYNAMICS AND CORRELATION WITH TEST MEASUREMENT ON BALL SEPARATOR MOTIONS Final Report, Sep. 1985 - Mar. 1986
C. R. Meeks Oct. 1986 98 p
(Contract F33615-84-C-2410)
(AD-A178423; HAC-FR-86-72-579; AFWAL-TR-86-2054) Avail: NTIS HC A05/MF A01 CSCL 13I

A high-speed computer program, SEPDYN, simulating all of the kinematics and dynamic motions of ball bearings, was used to analyze and predict ball separator motions of an oil-lubricated 100-mm-bore ball bearing. The predicted ball separator motions were compared with actual test data on separator motions in this bearing, and remarkable agreement was found between predictions and measurements. All conditions tested showed that the ball separator whirls at approximately the ball orbit frequency and the computer predictions are in agreement with the observation. The axial or angular tilting of the separator was observed to exhibit both higher frequency nutation or squeal as well as random, i.e., non-systematic motions. The computer predictions showed similar wave forms to the measured motions. Computer simulation times varied from 2 to 13 bearing race revolutions. One of the primary advantages of this computer program over other similar analysis routines is the highly efficient program design which minimizes computer run time while at the same time preserving a fully rigorous modeling of the bearing dynamics. All runs were completed within 17 minutes of CPU time on an IBM 3084QX mainframe. GRA

N87-24691# Tennessee Valley Authority, Chattanooga. Div. of Energy Demonstrations and Technology.
TEST AND EVALUATION OF THE TECHNICAL UNIVERSITY OF AACHEN RANGE PREDICTION DEVICE FOR ELECTRICAL VEHICLES Final Report
A. S. Keller Jan. 1987 150 p
(DE87-900615; TVA/OP/EDT-87/17) Avail: NTIS HC A07/MF A01

The Technical University of Aachen/Digatron Industrie-Elektronik GmbH Range Prediction Device (RPD) for electronic vehicles (EVs) was tested. The RPD provides the EV driver with a real-time estimate of remaining vehicle energy range based on calculations of remaining battery energy and energy consumption rate. RPDs were installed and tested in a Volkswagen Electrotransporter, a South Coast Technology/Volkswagen Rabbit,

and a General Motors Griffon van (all with lead-acid batteries). Three different types of test were used in the RPD evaluation: real world (city and highway driving), 56 km/h constant speed, and the SAE J227a C cycle. Range prediction data recorded during the tests were plotted and compared with theoretical values to determine accuracy. Root-mean-square error figures as low as 2.4 and relative errors as low as 0.0% were obtained during the evaluation period. DOE

N87-24692# Hanford Engineering Development Lab., Richland, Wash.
ADVANCES IN THE ELECTRO-SPARK DEPOSITION COATING PROCESS
R. N. Johnson and G. L. Sheldon Apr. 1986 26 p Presented at the International Conference on Metallurgical Coatings, San Diego, Calif., 7 Apr. 1986 Prepared in cooperation with Washington State Univ., Pullman
(Contract DE-AC06-76FF-02170)
(DE87-005455; HEDL-SA-3242-FP; CONF-860495-10) Avail: NTIS HC A03/MF A01

Electro-spark deposition (ESD) is a pulsed-arc micro-welding process using short-duration, high-current electrical pulses to deposit an electrode material on a metallic substrate. It is one of the few methods available by which a fused, metallurgically bonded coating can be applied with such a low total heat input that the bulk substrate material remains at or near ambient temperatures. The short duration of the electrical pulse allows an extremely rapid solidification of the deposited material and results in an exceptionally fine-grained, homogenous coating that approaches (and with some materials, actually is) an amorphous structure. This structure is believed to contribute to the good tribological and corrosion performance observed for hardsurfacing materials used in the demanding environments of high temperatures, liquid metals, and neutron irradiation. A brief historical review of the process is provided, followed by descriptions of the present state-of-the-art and of the performance and applications of electro-spark deposition coatings in liquid-metal-cooled nuclear reactors. DOE

N87-24693# Allied Bendix Corp., Kansas City, Mo.
CO2 AND Nd:YAG LASER WELDING OF STAINLESS STEEL AND BERYLLIUM COPPER VALVES Final Report
T. L. Hendrix Mar. 1987 47 p
(Contract DE-AC04-76DP-00613)
(DE87-007829; BDX-613-3711) Avail: NTIS HC A03/MF A01

Tests were conducted to evaluate Nd:YAG and CO2 lasers as alternates to electron beam welding of beryllium copper and stainless steel valves at Bendix Kansas City Division (BKC). Samples were welded and evaluated for all current requirements. Microphotographs of cross-sections were compared to the current electron beam welds. The Nd:YAG lasers were used to weld the beryllium copper valves. The data shows this process cannot consistently provide 0.010-inch minimum weld penetration, and large weld penetration variations can be expected. A 1000-watt CO2 laser was used to weld the stainless steel valves and was successful in meeting the requirements of two of the assemblies attempted. Penetration was limited to approximately 0.080 inch at full power (870 watts). The CO2 laser could not meet the penetration requirements (0.099 inch) of one of the assemblies attempted. DOE

N87-24694# Ford Motor Co., Dearborn, Mich. Research Staff.
ETX-I: FIRST GENERATION SINGLE-SHAFT ELECTRIC PROPULSION SYSTEM PROGRAM. VOLUME 1: POWERTRAIN Final Report
Feb. 1987 757 p Prepared in cooperation with General Electric Co., Schenectady, N.Y.
(Contract DE-AC08-82NV-10308)
(DE87-008354; DOE/NV-10308/H1-Vol-1) Avail: NTIS HC A99/MF A01

In 1981, discussions between Ford and General Electric (GE) evolved a concept for an advanced electric vehicle powertrain. The concept involved a combination of technology from Ford and GE that would result in a unique powertrain based on a motor and transmission concentric with the drive wheel axis, a concept originally proposed for use with Wankel engines, and based on the use of a hermetic, three-phase, alternating current (ac) motor, which is currently in high volume production in the necessary horsepower range. An additional benefit of this configuration is the ability to use a single fluid for cooling of the motor and lubrication of the transaxle. This volume describes the powertrain portion of the ETX-I program. DOE

N87-24695*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN APPLICATION OF RETRODUCTION TO ANALYZING AND TESTING THE BACKING OFF OF NUTS AND BOLTS DURING DYNAMIC LOADING
James J. Kerley Jun. 1987 72 p
(NASA-TM-4001; Rept-84F0269; NAS 1.15:4001) Avail: NTIS HC A04/MF A01 CSCL 13I

The method of retroduction, adapted from the doctoral thesis of Dr. A. Croce, relies on a process of dialectic questioning that begins with the information sought, proceeds to Given items (either in the form of dimensions or limits of research). and to Known mathematical forms of analysis in design or to principles of study in research. Finally, analysis and synthesis are used to abstract the dielectic questions and to arrive at the information desired. This method is used to solve the engineering design problem of a beam and to determine why bolts and nuts vibrate apart. Both mathematical analysis and dialectic logical analysis are utilized. Results are provided of tests conducted to check the retroductive study of why and how nuts back off. Author

N87-24696# Technical Research Centre of Finland, Espoo. Metals Lab.
ROBOT WELDING OF LARGE WORKPIECES, PRACTICAL EXPERIENCES
Kalervo Leino and Karri Vartiainen Oct. 1986 57 p In FINNISH; ENGLISH summary Sponsored by the Finnish Technology Development Center, and the Nordic Fund for Technology and Industrial Development
(VTT-435; ISBN-951-38-2698-8; ISSN-0358-5077; ETN-87-99839) Copyright Avail: NTIS HC A04/MF A01; Technical Research Center of Finland, Espoo, Finland FIM 48

Multipass fillet welding in different welding positions was studied. The effects of gaps and position errors of the welding head were evaluated. Weld starting and crater filling procedures were tested. The welding of T-joints and butt joints were compared. Robot programming of single pass and multipass welds were compared. Welding in a vertical position is time consuming. Positional errors are more critical than the gaps. The effects are smallest by welding in flat position and strongest in the horizontal-vertical position. The starting techniques require further development, but crater filling is satisfactory. Robot welding of butt joints in workshop conditions requires real time control of the welding parameters. Automatic subroutines make the robot programming for multipass welds less time consuming. On-line programming is not fast enough for individual workpieces. ESA

N87-24697# European Space Tribology Lab., Risley (England).
PERFORMANCE AND LIFE TESTING OF A QUALIFICATION MODEL DUAL WOUND MOTOR/GEARHEAD
J. C. Anderson Paris, France ESA Mar. 1986 67 p
(Contract ESTEC-5710/83-NL-PP)
(ESA-ESTL-78; ESA-CR(P)-2317; ETN-87-99873) Avail: NTIS HC A04/MF A01

A size 18 dual-wound, permanent magnet dc motor, coupled to a size 18 precision gearhead, was subjected to ambient and vacuum performance tests and accelerated life testing. The gearhead was lubricated with a perfluoropolyether based grease. The motor/gearhead performs satisfactorily at ambient and in vacuum over a range of temperature from plus 80 to minus 45 C, and during an extensive life test in ambient and in vacuum. Performance is nominal after life testing. The motor gearhead

accumulated 257 hr of operation, 50% in vacuum. The unit meets all the performance criteria. The current required for an output torque of 180 oz.in. (1.27 Nm) is in the range 300 to 380 mA. On completion of the tests the motor gearhead was in good condition. ESA

N87-24698 Virginia Polytechnic Inst. and State Univ., Blacksburg.
AN EXPERIMENTAL STUDY OF FRICTIONAL PHENOMENA AROUND THE PIN JOINTS OF PLATES USING MOIRE INTERFEROMETRY Ph.D. Thesis
Duksung Joh 1986 123 p
Avail: Univ. Microfilms Order No. DA8704677

Although contact problems with friction have received considerable attention in recent years, analytical as well as experimental limitations have tended to obscure some of their essential features. Techniques employed in the past lacked either required sensitivity or adequate spatial resolution for local measurements of deformation near the contact surface. Further, most techniques also did not allow the use of prototype material which is crucial for investigation of contact stress problems with friction. In the present study, a relatively new experimental method, which was developed at VPI and SU, is employed; high-sensitivity Moire interferometry. Using a clearance pin-joint model made of prototype structural material, Aluminum 7071-T6, studies on frictional phenomena between the pin and plate are conducted to provide a comprehensive treatment of the following subjects: slip-stick phenomena, variation of contact zone, distribution of frictional force at the contact region, effects of frictional shear stress on stress concentration, and identification of slip amplitude. The results showed a strong influence of friction, including significant differences in the load-increasing and load-decreasing phases. Dissert. Abstr.

N87-24699# Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.
UNSTEADY FLOW PHENOMENA IN CENTRIFUGAL TURBOMACHINERY Final Technical Report
D. A. Fink 8 Sep. 1986 4 p
(Grant AF-AFOSR-0343-84)
(AD-A179714; AFOSR-87-0554TR) Avail: NTIS HC A02/MF A01 CSCL 20D

The research is an experimental investigation of system dynamics, unsteady effects, and detailed flow instabilities in a centrifugal compressor. The surge line, which marks the onset of instability and hence limits the minimum stable operating regime, is a primary design constraint in matching the compressor to downstream turbine and combustor (gas turbine gas generator) or diesel engine (turbocharger). The ultimate goal of this research is a thorough understanding of the events occurring in the compression system which cause surge. GRA

N87-24700*# National Aeronautics and Space Administration, Washington, D.C.
DYNAMIC FORCE SIGNAL PROCESSING SYSTEM OF A ROBOT MANIPULATOR
M. Uchiyama, K. Kitagaki, and K. Hakomori Jul. 1987 6 p Transl. into ENGLISH of "Robot Manipulator No Doteki Ryoku Singo Shori System" rept. JS-24-4 Sice, Tokyo, Japan, 23-25 Jul. 1986 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20066; NAS 1.77:20066; JS-24-4) Avail: NTIS HC A02/MF A01 CSCL 13I

If dynamic noises such as those caused by the inertia forces of the hand can be eliminated from the signal of the force sensor installed on the wrist of the robot manipulator and if the necessary information of the external force can be detected with high sensitivity and high accuracy, a fine force feedback control for robots used in high speed and various fields will be possible. As the dynamic force sensing system, an external force estimate method with the extended Kalman filter is suggested and simulations and tests for a one axis force were performed. Later a dynamic signal processing system of six axes was composed and tested. The results are presented. Author

N87-24701*# National Aeronautics and Space Administration, Washington, D.C.
DYNAMIC SENSING OF 6-AXIS EXTERNAL FORCE AND MOMENT APPLIED TO A ROBOT END
Masaru Uchiyama Yokota and Kyojiro Kakomori Jul. 1987 22 p Transl. into ENGLISH from Journal of the Robotics Society of Japan (Japan), v. 4, no. 6, Dec. 1986 p 3-11 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20065; NAS 1.77:20065) Avail: NTIS HC A02/MF A01 CSCL 13I

A dynamic force sensing method is proposed for a robot manipulator. A 6-axis wrist force sensor which is commonly used for robot force sensing does not take the direct measurement of the force and moment applied to an end effector externally from the environment of the manipulator, but takes the resultant of the gravity, the inertial force and moment on the end effector, and the external force and moment. The separation of gravitational and inertial force and moment from the measurement of the force sensor is crucial to achieving dynamically accurate force sensing and fast manipulator motion under force feedback control. A mathematical model is derived for the force sensing process and the separation of the force and moment as a nonlinear optimal state estimation problem formulated. Then an approximate solution is given using extended Kalman filtering techniques. Author

N87-24702# Sandia National Labs., Albuquerque, N. Mex.
TWO-AXIS, CLOSED-LOOP PIEZOELECTRIC IMAGE STABILIZER FOR USE WITH STARING-ARRAY PHOTODETECTORS
W. D. Williams and D. J. Brunty Apr. 1987 10 p
(Contract DE-AC04-76DP-00789)
(DE87-009090; SAND-86-2100) Avail: NTIS HC A02/MF A01

An image-tracking and stabilizing device has been built, tested, and characterized. This device uses the Burleigh Inchworm piezoelectric micropositioner to maintain a focused image of a bright object on a staring photodetector array. It is capable of both the large-angle, rapid displacements (in excess of 20° at 100 mrad/s) required for tracking moving objects and the precise, small-angle displacements required for image-jitter stabilization (within +-0.5 mm) on a staring-array photodetector. DOE

N87-24703# British Library Lending Div., Boston Spa (England).
DEUTSCHES KUPFER INSTITUT (DKI) WELDING OF COPPER
[1987] 18 p Transl. into ENGLISH of unidentified German document
(BLL-M-50390-(5828.4)) Avail: British Library Lending Div., Boston Spa, Engl.

Two basic types of copper welding are discussed. The two types are pressure welding and fusion welding, both of which are discussed in detail. Some points emphasized in copper welding and which are briefly discussed are: high thermal conductivity, high thermal expansion, and the tendency in the liquid state to take up gases which are expelled on solidification and can produce pores. E.R.

N87-24499*# Honeywell Systems and Research Center, Minneapolis, Minn.
ROBUST CONTROL FOR LARGE SPACE ANTENNAS
M. F. Barrett *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 637-664 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 13I

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N87-24704# Army Military Personnel Center, Alexandria, Va.
SOLUTION TO A CLASS OF ECONOMIC RELIABILITY PROBLEMS WITH GEOMETRIC PROGRAMMING Final Report
Cecilia K. Oatney 14 Apr. 1987 96 p
(AD-A179173) Avail: NTIS HC A05/MF A01 CSCL 09C

The rapid advancement of technology in the electronic industry has created a need for solving a certain class of large nonlinear reliability problems. The Department of Defense and civilian industries when planning for the allocations of budget resources require an efficient method for solving these problems. In certain areas a specific reliability, such as with nuclear reactors, must be attainable to ensure the accomplishment of the mission or to provide necessary safety factors. The current methods used to solve these problems are very difficult and time consuming. A computer algorithm which is based on geometric programming has been developed to provide a quick, accurate, and efficient way of solving reliability problems. GRA

N87-24705# Lawrence Livermore National Lab., Calif.
ORGANIZING FOR QUALITY: A STRUCTURAL PERSPECTIVE
J. J. Dronkers Jan. 1987 23 p Presented at the 41st Annual Quality Conference, Minneapolis, Minn., 4 May 1987
(Contract W-7405-eng-48)
(DE87-004356; UCRL-95891; CONF-870544-3) Avail: NTIS HC A02/MF A01

This paper discusses an aspect of QA program implementation that often has been overlooked: existing organizational structures. The paper's premise is that existing organizational structures have a great deal to do with an organization's culture and therefore must be considered when implementing QA programs. The paper reviews major quality assurance program descriptions as found in several standards and in the writings of Crosby, Feigenbaum, and Juran. The review shows that quality assurance programs are concerned with both quality achievement and demonstrability of that achievement. Next, a review of organizational structures is considered. Two traditional ones: hierarchical and matrix structures, and an emerging one, parallel structure. Characteristic traits of each and their importance are discussed. The paper concludes by suggesting a method for implementing QA programs to existing structures. The method contemplated places the QA professional in the role of change agent. The method's basis is a critical review of what is needed in a QA program, and what already exists in the structure. DOE

N87-24706# Sandia National Labs., Albuquerque, N. Mex.
DEVELOPMENT OF A LINEAR PIN WEAR TEST MACHINE
D. T. Schmale and R. J. Bourcier Apr. 1987 24 p
(Contract DE-AC04-76DP-00789)
(DE87-009236; SAND-87-0742) Avail: NTIS HC A02/MF A01

In support of a study of the mechanical properties of amorphous alloys produced by laser surface melting, a linear pin wear test machine has been developed and constructed. The machine repeatedly follows a single straight path in one direction through the use of simple kinematic principles. The wear pin is held in a tone arm-like assembly which rides on an off-center rotating bearing. Wear track length can be adjusted by varying bearing eccentricity and tone-arm offset, while wear track location may be changed by specimen translation via two micrometer mounted ball slides. Frictional force is measured by using a load cell mounted on precision bearings while displacement is monitored by using a precalibrated LVDT. The specimen holder is designed to hold irregular specimens up to 0.46 x 1.90 x 2.54 cm. Selected frictional load and displacement data are recorded using a digital oscilloscope. Results of tests performed on an annealed 304 stainless steel specimen using a 350 maraging steel pin are presented. DOE

N87-24707*# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
ONE-DIMENSIONAL WAVE PROPAGATION IN RODS OF VARIABLE CROSS SECTION: A WKBJ SOLUTION Final Report
Simeon C. U. Ochi and James H. Williams, Jr. Washington NASA Jul. 1987 92 p
(Grant NAG3-328)
(NASA-CR-4086; E-3651; NAS 1.26:4086) Avail: NTIS HC A05/MF A01 CSCL 14D

As an important step in the characterization of a particular dynamic surface displacement transducer (IQI Model 501), a one-dimensional wave propagation in isotropic nonpiezoelectric and piezoelectric rods of variable cross section are presented. With the use of the Wentzel-Kramers-Brillouin-Jeffreys (WKBJ) approximate solution technique, an approximate formula, which relates the ratio of the amplitudes of a propagating wave observed at any two locations along the rod to the ratio of the cross sectional radii at these respective locations, is derived. The domains of frequency for which the approximate solution is valid are discussed for piezoelectric and nonpiezoelectric materials. Author

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N87-24708# Allied Bendix Corp., Kansas City, Mo.
INVESTIGATION OF ULTRASONIC METHODS FOR RESIDUAL STRESS MEASUREMENT IN METALS Annual Report
G. D. Swanson Feb. 1987 20 p
(Contract DE-AC04-76DP-00613)
(DE87-006578; BDX-613-3685) Avail: NTIS HC A02/MF A01

Three ultrasonic methods and one combination of methods were investigated for nondestructively measuring residual stress in metals. Shear wave birefringence measurements on samples cut from drawn metal rods showed no texture for axial wave propagation, but significant texture for wave propagation normal to the axis. Surface wave velocity measurements made over a wide range of wave propagation angles in a severely textured rolled metal bar showed no evidence of any excluded propagation directions. A shear horizontal wave generator made with a contact shear transducer coupled to a Plexiglas wedge was used with a two-knife edge receiver to create a compact transducer assembly. A combination of results from shear wave birefringence and surface wave velocity measurements, when described using crystallite orientation distribution functions, has the potential for directly separating the effects of texture and stress. DOE

N87-24709*# Edighoffer, Inc., Newport News, Va.
DYNAMIC AND THERMAL RESPONSE FINITE ELEMENT MODELS OF MULTI-BODY SPACE STRUCTURAL CONFIGURATIONS Final Report
Harold H. Edighoffer Apr. 1987 156 p
(Contract NAS1-17210)
(NASA-CR-178289; NAS 1.26:178289) Avail: NTIS HC A08/MF A01 CSCL 20K

Presented is structural dynamics modeling of two multibody space structural configurations. The first configuration is a generic space station model of a cylindrical habitation module, two solar array panels, radiator panel, and central connecting tube. The second is a 15-m hoop-column antenna. Discussed is the special joint elimination sequence used for these large finite element models, so that eigenvalues could be extracted. The generic space station model aided test configuration design and analysis/test data correlation. The model consisted of six finite element models, one of each substructure and one of all substructures as a system. Static analysis and tests at the substructure level fine-tuned the finite element models. The 15-m hoop-column antenna is a truss

column and structural ring interconnected with tension stabilizing cables. To the cables, pretensioned mesh membrane elements were attached to form four parabolic shaped antennae, one per quadrant. Imposing thermal preloads in the cables and mesh elements produced pretension in the finite element model. Thermal preload variation in the 96 control cables was adjusted to maintain antenna shape within the required tolerance and to give pointing accuracy. Author

N87-24710# Pennsylvania Univ., Philadelphia. Dept. of Mechanical Engineering and Applied Mechanics.
CRACK-TIP FIELDS FOR MATERIALS WITH EXPONENTIAL-LAW-CREEP BEHAVIOR AT HIGH STRESS Final Report
J. L. Bassani Mar. 1987 8 p
(Contract DE-AC02-83ER-13037)
(DE87-008905; DOE/ER-13037/1) Avail: NTIS HC A02/MF A01

This work focused on elastic-viscoplastic analyses of cracks under creep conditions, with particular emphasis on the influence of the assumed stress dependence on the creep strain-rate. At high stress levels the creep strain-rate for many structural materials varies as the exponential of stress while at low stress levels it varies as stress to some power. The complete stress dependence is given in terms of the known hyperbolic-sine creep law. DOE

N87-24711# Los Alamos National Lab., N. Mex.
THREE ELASTIC-PLASTIC MODELS
W. A. Cook Apr. 1987 32 p
(Contract W-7405-eng-36)
(DE87-009477; LA-10924-MS) Avail: NTIS HC A03/MF A01

This report presents three elastic-plastic models used extensively in hydrodynamic and structural computer codes. Each model uses the von Mises yield condition and is valid for large deformations but limited to small strains. The models are (1) a simple elastic-(perfectly) plastic model that scales the stresses to the yield surface when yielding has occurred, (2) the Prandtl-Reuss model that is also elastic-(perfectly) plastic but ensures plastic dilatation is zero, and (3) an elastic-plastic model with both isotropic and kinematic hardening. Though the derivations are limited to small-strain concepts, these models are often used for finite strains by interpreting the stresses as Cauchy stresses. DOE

N87-24712# International Centre for Theoretical Physics, Trieste (Italy).
EFFECT OF THE DISLOCATION IMAGE FORCE ON THE BRITTLE BEHAVIOUR OF MATERIALS
C. W. Lung Jun. 1986 16 p
(DE87-701782; IC-86/109) Avail: NTIS (US Sales Only) HC A02/MF A01

The dislocation image force due to the free surface of a finite width specimen makes the plastic zone at a crack tip larger. The effect of the dislocation image force on the fracture behaviour of materials with different geometrical shapes is discussed. It is found that the ratio V/A as an indication of the brittle behaviour of structural components is reasonable for elastic-plastic fracture. DOE

N87-24713 Harvard Univ., Cambridge, Mass.
DUCTILE AND BRITTLE CRACK TIP RESPONSE Ph.D. Thesis
Peter Martin Anderson 1986 223 p
Avail: Univ. Microfilms Order No. DA8704386

A combination of analyses employing elastic fracture mechanics, dislocation theory, and classical thermodynamics are used to investigate a fundamental viewpoint of ductile and brittle behavior of cracks in and along the interface between crystalline materials. The general viewpoint examined is that a sharp crack, which is regarded as an essential ingredient to brittle material response, may only exist if the generation of dislocations from either the crack tip or surrounding sources and their subsequent motion does not first blunt and relax stresses around the sharp crack before the Griffith load is reached. Specifically, the analyses presented use micromechanical models to estimate the critical crack tip load, measured in terms of a set of elastic stress intensity factors. Recent developments in three-dimensional crack-defect interactions as well as analogous two-dimensional studies are used to properly model the elastic energy of a semicircular loop emanating from a loaded, sharp crack. Further, a thermodynamic analysis is developed to study the effects of a chemical impurity on the competition between cleavage extension and crack tip dislocation emission. The models developed are applied to make predictions of ductile and brittle crack tip response for specific crack geometries in several pure f.c.c. and b.c.c. materials. Dissert. Abstr.

N87-24714 Harvard Univ., Cambridge, Mass.
THE PLASTIC YIELDING OF POROUS METALS Ph.D. Thesis
Mark Edward Mear 1986 114 p
Avail: Univ. Microfilms Order No. DA8704430

A family of dilatant plasticity theories is introduced by considering yield surfaces which change according to a combination of isotropic expansion and kinematic translation. The family of constitutive laws is constructed such that all versions coincide for proportional stressing histories. The accuracy of the constitutive relations is addressed through detailed calculation for void arrays. The macroscopic stress-strain response of this cell is determined for different matrix hardening characteristics and linear axisymmetric stressing paths, and the results are compared with the predictions of Gurson's theory and Tvergaard's modification of it. It was found that Gurson's original theory performs adequately in predicting this response. The structure of the macroscopic yield surface is explored in detail, and it is demonstrated that a vertex exists at the loading point despite the face that the plasticity formulation used to model the matrix material is characterized by a smooth yield function. The effect of void clustering is explored by considering an array in which cylinder voids are clustered together in an idealized fashion. Dissert. Abstr.

N87-24715 Iowa State Univ. of Science and Technology, Ames.
STUDY OF MIXED MODE STRESS INTENSITY FACTORS BY TWO- AND THREE-DIMENSIONAL PHOTOELASTICITY Ph.D. Thesis
Tae Hyun Baek 1986 204 p
Avail: Univ. Microfilms Order No. DA8703686

An experimental study was performed to investigate the stress intensity factors from two-dimensional inclined edge cracked models and three-dimensional inclined semi-circular surface cracks that penetrate part-way through a thick plate. To improve the accuracy of photoelastic data collection, fringe multiplication and fringe sharpening techniques with a digital image processing system were used. Fracture coefficients, together with the exact origin of the crack tip, were extracted from data sets that produced an overdeterministic system of equations solved by an iterative least squares method. Power series type Williams equations were used in the analysis. The accuracy of the experimental results were evaluated qualitatively and quantitatively. The accuracy evaluation indicates that the first four terms of the Williams equations are sufficient to describe the stress field in the vicinity of the crack tip for both mode 1 and mixed mode cases. It was found that the modified Westergaard equations or the first two terms of the Williams equations cannot be used to extract mixed mode fracture parameters. The average values of the experimental results, K(I)/K(I 0) and K(II)/K(I), for the two-dimensional inclined edge cracked plates lie within the range of numerical solutions and previous experimental values. Additional results are discussed. Dissert. Abstr.

N87-24716 Iowa State Univ. of Science and Technology, Ames.
EXPERIMENTAL FRACTURE MECHANICS THROUGH DIGITAL IMAGE ANALYSIS Ph.D. Thesis
Alireza Mehdi-Soozani 1986 152 p
Avail: Univ. Microfilms Order No. DA8703731

In this study two-dimensional mixed mode stress intensity factors for a crack tip in the neighborhood of a free edge or another crack tip were detemined both experimentally and numerically. In the experimental approach on-line digital image

analysis procedures are used to extract photoelastic data from the whole field isochromatic fringe patterns. Two different techniques were used to obtain information on the near crack tip stress field: (1) Half Fringe Photoelasticity (HFP), which requires adjusting the load to keep the maximum fringe order less than 0.5 in the data extraction zone, and (2) Trace, a digital fringe sharpening procedure, which accurately produces traces of all half- and full-order fringes. The load is adjusted to yield multiple fringes in the field of data extraction. Numerical SIFs were determined by the boundary integral equation method and compared to experimental results. Dissert. Abstr.

N87-24717 Old Dominion Univ., Norfolk, Va.
AN ANALYTICAL AND EXPERIMENTAL STUDY OF CLEARANCE AND BEARING-BYPASS LOAD EFFECTS IN COMPOSITE BOLTED JOINTS Ph.D. Thesis
Rajiv Vikas Arun Naik 1986 183 p
Avail: Univ. Microfilms Order No. DA8703789

A combined analytical and experimental study is conducted to determine the effects of clearance and bearing-bypass loading for mechanically fastened joints in composites. A simple method of analysis is developed to account for the nonlinear effects of bolt-hole clearance. The nonlinear load-contact variations for clearance-fit fasteners are also measured using specially instrumented fasteners. For a quasi-isotropic graphite/epoxy laminate, results show that the contact arc as well as the peak stresses around the hole and their locations are strongly influenced by the clearance. Quasi-isotropic graphite/epoxy laminates (T300/5208) are tested under combined bearing and bypass loading to study failure modes and strengths. Radiographs were made after damage onset and after ultimate load to examine the failure modes. Also the laminate stresses near the bolt-hole are calculated for each test condition, and then used with appropriate failure criteria to analyze the test data. Strength predictions indicate that damage corresponding to ultimate strength is governed by the maximum stress near the hole. This investigation will help improve the basic understanding of composite bolted joints and lead to better structural design procedures. Dissert. Abstr.

N87-24718# Aeronautical Research Inst. of Sweden, Stockholm.
FATIGUE CRACK GROWTH: STATISTICAL CONSIDERATIONS
A. F. Blom and B. Palmberg Jan. 1987 39 p Proposed for presentation at the FATIGUE 87, Charlottesville, Va., 28 Jun. - 3 Jul. 1987 Sponsored by the Swedish Defence Material Administration, and the Swedish Board for Technical Development
(FFA-TN-1987-04; ETN-87-99784) Avail: NTIS HC A03/MF A01

All the parameters of importance in a damage tolerance analysis are treated. Sources of scatter in fatigue crack growth during service loading are reviewed. Stochastic fatigue crack growth models are discussed. Limitations in such models are pointed out and are partly accounted for by modification of models. ESA

N87-24719# New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.
DAMAGE DIAGNOSIS FOR ELASTO-PLASTIC STRUCTURES Technical Report, Jan. - Dec. 1986
Frederick D. Ju and Fashin C. Chang Dec. 1986 225 p
(Grant AF-AFOSR-0085-85)
(AD-A179772; ME-138(86)AFOSR-993-2; AFOSR-87-0413TR)
Avail: NTIS HC A10/MF A01 CSCL 20K

The present report established a probabilistic characterization of a damaged structure, which is modeled as an nonlinear multi-degree-of-freedom (MDF) system. The random excitation maybe either stationary or nonstationary. The stiffness matrix is nonlinear to stimulate the elasto-plastic behavior of a damaged structure. The stiffness matrix is also random to characterize the material and environmental varations. The governing stochastic differential equation is resolved into one for the mean response and another for its random component. The responses, their statistical moments and cross-moments are solved with discrete-time recurrence formulations. The omission of the higher order terms in obtaining the response statistics is admissible if the stiffness does not behave extremely random. Both errors in the mean and variance responses, which arise from neglecting the higher order terms, are not small order. GRA

N87-24720# Akron Univ., Ohio. Inst. of Polymer Science.
INTERNAL FRACTURE IN AN ELASTOMER CONTAINING A RIGID INCLUSION
K. Cho, A. N. Gent, and P. S. Lam May 1987 38 p
(Contract N00014-85-K-0222)
(AD-A179782; TR-8) Avail: NTIS HC A03/MF A01 CSCL 11J

Rubber blocks were prepared with thin glass rods in their centers, firmly bonded to the surrounding rubber. A tensile stress applied to the ends of a block in the direction of the rod axis induced the sudden formation of voids in the rubber near the flat ends of the rod. Approximate values of the local stresses have been calculated by the finite element method , assuming linear elastic behavior. Voids were found to form when and where the local dilatant stress -P (negative hydrostatic pressure) exceeded the magnitude of Young's modulus E for the rubber. A precursor void in a highly-elastic solid would expand indefinitely under these circumstances, so that fracture seems to be the result of an elastic instability. The applied stress at which voids appeared was of the same order as E for short rods, or for a butt joint between a rod and a rubber cylinder of the same diameter, but it became extremely small when the rod was thin compared to the block in which it was embedded, and relatively long. Under these circumstances the local dilatant stress is calculated to be a large multiple of the applied tensile stresss. GRA

N87-24721# Army Armament Research and Development Command, Watervliet, N. Y. Weapons Lab.
AN EVALUATION OF THE SERVICE FAILURE OF ALUMINUM NOSE CONES USING FOUR TEST TECHNIQUES Final Report
J. A. Kapp, R. R. Fujczak, and R. T. Abbott Mar. 1987 24 p
(AD-A179971; ARCCB-TR-87006) Avail: NTIS HC A02/MF A01 CSCL 11F

Service failure of 7075-T6 aluminum nose cones was evaluated by four techniques: 1. Residual stress measurements (hole drilling technique). 2. Notched crack initiation toughness tests. 3. Verification of fracture toughness. 4. Simulation tests of finished nose cones. In this examination, residual stress differences contributed most to the failure analysis. GRA

N87-24722*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HUB FLEXIBILITY EFFECTS ON PROPFAN VIBRATION
Michael A. Ernst and Charles Lawrence Jul. 1987 16 p
(NASA-TM-89900; E-3596; NAS 1.15:89900) Avail: NTIS HC A02/MF A01 CSCL 20K

The significance of hub flexibility in the nonlinear static and dynamic analyses of advanced turboprop blades is assessed. The chosen blade is the 0.175 scale model of the GE-A7-B4 unducted fan blade. A procedure for coupling the effective hub stiffness matrix to an MSC/NASTRAN finite element model is defined and verified. A series of nonlinear static and dynamic analyses are conducted on the blade for both rigid and flexible hug configurations. Results indicate that hub flexibility is significant in the nonlinear static and dynamic analyses of the GE-A7-B4. In order to insure accuracy in analyses of other blades, hub flexibility should always be considered. Author

N87-24723*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
CHARACTERIZATION AND HARDWARE MODIFICATION OF LINEAR MOMENTUM EXCHANGE DEVICES
George D. Edgemon, Sally Curtis (Control Dynamics Co., Huntsville, Ala.), and Henry B. Waites Mar. 1987 44 p
(NASA-TM-86594; NAS 1.15:86594) Avail: NTIS HC A03/MF A01 CSCL 20K

A sequence of modifications were made on the TRW Linear Momentum Exchange Devices (LMEDs) which were supplied for a joint MSFC/Air Force Wright Aeronautical Laboratory (AFWAL) control venture called Vibrational Control of Space Structures (VCOSS)-II. The modifications were necessary to alleviate and assuage the LMED nonlinearities. Extensive discussion of the LMED modification are presented along with the test plan, test results and conclusions. In addition, a chronology of events, relative to the LMED changes, is given. Author

N87-24724*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STRESS-INTENSITY FACTOR CALCULATIONS USING THE BOUNDARY FORCE METHOD
P. W. Tan, I. S. Raju (Analytical Services and Materials, Inc., Hampton, Va.), and J. C. Newman, Jr. Jun. 1987 40 p
(NASA-TM-89158; NAS 1.15:89158) Avail: NTIS HC A03/MF A01 CSCL 20K

The Boundary Force Method (BFM) was formulated for the three fundamental problems of elasticity: the stress boundary value problem, the displacement boundary value problem, and the mixed boundary value problem. Because the BFM is a form of an indirect boundary element method, only the boundaries of the region of interest are modeled. The elasticity solution for the stress distribution due to concentrated forces and a moment applied at an arbitrary point in a cracked infinite plate is used as the fundamental solution. Thus, unlike other boundary element methods, here the crack face need not be modeled as part of the boundary. The formulation of the BFM is described and the accuracy of the method is established by analyzing a center-cracked specimen subjected to mixed boundary conditions and a three-hole cracked configuration subjected to traction boundary conditions. The results obtained are in good agreement with accepted numerical solutions. The method is then used to generate stress-intensity solutions for two common cracked configurations: an edge crack emanating from a semi-elliptical notch, and an edge crack emanating from a V-notch. The BFM is a versatile technique that can be used to obtain very accurate stress intensity factors for complex crack configurations subjected to stress, displacement, or mixed boundary conditions. The method requires a minimal amount of modeling effort. Author

N87-24725# Cambridge Univ. (England). Dept. of Engineering.
ON THE MODULUS OF KFRP LAMINATES IN STATIC AND FATIGUE LOADING
H. L. Ganczakowski, P. A. Smith, and Peter W. R. Beaumont Feb. 1987 12 p
(CUED/C-MAT/TR137; ISSN-0309-6505) Avail: NTIS HC A02/MF A01

The behavior of unidirectional and cross ply Kevlar fiber reinforced plastic (KFRP) laminates was studied under static and fatigue loading. The stiffness of unidirectional laminates was shown to increase under static loading and with fatigue cycling, although on unloading it may subsequently return to its original value. For cross ply laminates, a decrease in stiffness under static loading was found, due to matrix cracking in the transverse plies. Under fatigue loading, the stiffness changes of the cross ply laminate were found to be complicated by the stiffening of the unidirectional layers. Author

N87-24726# Cambridge Univ. (England). Dept. of Engineering.
UPPER-BOUND PLASTIC COLLAPSE ANALYSIS OF FRAMEWORKS
S. Pellegrino 1987 18 p
(CUED/D-Struct/TR118; ISSN-0309-7447) Avail: NTIS HC A02/MF A01

An efficient and general, yet physically understandable, scheme was developed to obtain the collapse load factor of an arbitrary framed structure using an upper-bound approach. The most general mechanism of collapse is expressed by a linear combination of the elementary mechanisms, and the corresponding load multiplier lambda is obtained by equating work done by the applied loads to the plastic energy dissipated. The minimum of lambda is the required collapse load. Having examined the properties of lambda, a new matrix method to find its minimum is devised; a simple example illustrates the calculations. The method of minimization does not require non-negative variables as in previous schemes based on the Simplex method, and thus results in an algorithm which reduces computer storage and time requirements. Author

N87-24727# Cambridge Univ. (England). Dept. of Engineering.
THE MICROMECHANICS OF COMPOSITE FRACTURE
Peter W. R. Beaumont May 1987 31 p
(CUED/C-Mats/TR138; ISSN-0309-6505) Avail: NTIS HC A03/MF A01

A polymer containing long fibers, spherical particles, or precipitates can fail by any one or combination of a number of often competing mechanisms of fracture: breakage of a brittle fiber or particle, tearing of a rubbery precipitate, decohesion (debonding) at the matrix-reinforcement interface, matrix cavitation and plastic flow, crazing, shear banding, or microcracking. These failure processes have characteristics that depend on the microstructure and the properties of the matrix, inclusion, and interface. Models are presented whereby the dissipation of energy of the various failure mechanisms are derived and the potential contributions to the toughness of the composites quantified. The models give guidance to the ways in which composite materials can be toughened and they help identify the dominant mechanism of failure in the monotomic or cyclic loading of the cracked material. Predictions of toughness are made for 3 classes of polymeric-composites: polymers containing brittle fibers, polymers containing rubbery precipitates, and polymers containing brittle particles. Author

N87-24728# British Library Lending Div., Boston Spa (England).
ACCUMULATION OF PERMANENT DEFORMATION DURING SHORT CYCLE ASYMMETRICAL BEND FATIGUE TESTS
Yu. V. Svitich, D. L. Krasavin, and V. F. Sukhovarov [1986] 4 p Transl. into ENGLISH from Izvestiya Vysshikh Uchebnykh Zavedeniy Chernaya Metallurgiya (USSR), no. 10, 1986 p 150-151
(BLL-M-37185-(5828.4)) Avail: British Library Lending Div., Boston Spa, Engl.

Fatigue tests are described which were made on sheet specimens of several industrial alloys tested in different structural states after different heat treatments. It was found that permanent deformations are related to the number of test cycles in an inconsistent manner, rises and drops in permanent deformation being caused by the formation of microcracks. Elastic sensing elements may remain efficient right up to when a main crack forms. The results must be used in building up physical models and in experiments to study short cycle fatigue fracture. Author

42 GEOSCIENCES (GENERAL)

N87-24729# Joint Publications Research Service, Arlington, Va.
CHINA REPORT: SCIENCE AND TECHNOLOGY
2 May 1986 88 p Transl. into ENGLISH from various Chinese articles
(JPRS-CST-86-016) Avail: NTIS HC A05/MF A01

Topics addressed include: national developments; physical sciences; applied sciences; scientists and scientific organizations; and environmental quality. For individual titles, see N87-24730 through N87-24732.

N87-24730# Joint Publications Research Service, Arlington, Va.
WIND, KUROSHIO SYSTEM ACTION ON EAST CHINA SEA CIRCULATION c48
Fengshu Liu *In its* China Report: Science and Technology 2 May 1986 p 41-47 Transl. into ENGLISH from Haiyang Kexue (Beijing, China), v. 9, no. 3, 9 May 1985 p 1-4 (For primary document see N87-24729 18-42)
Avail: NTIS HC A05/MF A01

The circulation in the East China Sea is described using the balance equation of wind stress curl and lateral stress curl. Analysis shows that the Kuroshio system plays a determinant role and the wind stress only acts as an adjustment factor in generation of the circulation. Author

N87-24731# Joint Publications Research Service, Arlington, Va.
HIGH RESOLUTION SEA SURFACE TEMPERATURE FIELD DERIVED c48
Sisong Zhou, Weiying Chen, and Lixia Zhang *In its* China Report: Science and Technology 2 May 1986 p 48-55 Transl. into ENGLISH from Haiyang Kexue (Beijing, China), v. 9, no. 3, 9 May 1985 p 5-9 (For primary document see N87-24729 18-42)
Avail: NTIS HC A05/MF A01

A procedure for deriving high resolution sea surface temperature field from digital AVHRR/HRPT data is described. For the purpose of reducing the processing time, only the reflective threshold or near infrared channel is used for selecting data over clear areas of ocean. The W.L. Smith single window channel sea surface temperature retrieval method is used for atmospheric attenuation correction for the area of Beihai Bay and the Yellow Sea during the cold half of the year. Compared with other measurements, the result is quite satisfactory. Author

N87-24732# Joint Publications Research Service, Arlington, Va.
NEW MODEL He-Ne LASER TUBES TESTED c36
Yuzhi Wang and Zonglin Huang *In its* China Report: Science and Technologt 2 May 1986 p 56-64 Transl. into ENGLISH from Dianzi Xuebao (Beijing, China), v. 13, no. 4, Jul. 1985 p 50-56 (For primary document see N87-24729 18-42)
Avail: NTIS HC A05/MF A01

Three specially fabricated tubes (ordinary type, modification 1, and modification 2) and seven different gases (He, Ne, He-Ne mixture, Ar, Kr, H2, and N2) were used in experimental studies of the mechanism by which the ignition voltage is lowered in a He-Ne laser tube invented by the Tianjin Laser Research Institute. The experiments showed that the modified versions had lower ignition voltages, but only in a certain pressure range, and that as the pressure rose to some value of P sub o, which depended on the type of gas, the size of the ignition voltage decrease approached zero. A theoretical explanation of the experimental results is given. Author

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N87-24733*# California Univ., Santa Barbara. Dept. of Environmental Studies.
[EARTH SCIENCE RESEARCH] Final Report
Daniel B. Botkin 4 May 1987 9 p
(Grant NAG5-548)
(NASA-CR-180512; NAS 1.26:180512) Avail: NTIS HC A02/MF A01 CSCL 05B

The analysis of ground-truth data from the boreal forest plots in the Superior National Forest, Minnesota, was completed. Development of statistical methods was completed for dimension analysis (equations to estimate the biomass of trees from measurements of diameter and height). The dimension-analysis equations were applied to the data obtained from ground-truth plots, to estimate the biomass. Classification and analyses of remote sensing images of the Superior National Forest were done as a test of the technique to determine forest biomass and ecological state by remote sensing. Data was archived on diskette and tape and transferred to UCSB to be used in subsequent research. B.G.

N87-24734# Defense Mapping Agency Aerospace Center, St. Louis, Mo.
PRELIMINARY RESULTS OBTAINED BY DMAAC FROM THE PROCESSING OF A LIMITED SET OF GEOSAT SATELLITE RADAR ALTIMETER DATA
Dennis H. VanHee 19 Nov. 1986 15 p
(AD-A179081) Avail: NTIS HC A02/MF A01 CSCL 17I

Details of the activities associated with the processing of GEOSAT satellite radar altimetry data are discussed. Summary statistics and observations obtained during the processing of a limited set of GEOSAT altimeter data are presented. Statistics from comparisons of GEOSAT-derived mean gravity anomalies with those obtained from available survey data are shown. Future plans and directions for the continued processing and exploitations of this data are indicated. GRA

N87-24735*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
NEW DIMENSION ANALYSES WITH ERROR ANALYSIS FOR QUAKING ASPEN AND BLACK SPRUCE
K. D. Woods, D. B. Botkin, and A. H. Feiveson 1987 66 p
(NASA-TM-89219; NAS 1.15:89219) Avail: NTIS HC A01/MF A01 CSCL 02F

Dimension analysis for black spruce in wetland stands and trembling aspen are reported, including new approaches in error analysis. Biomass estimates for sacrificed trees have standard errors of 1 to 3%; standard errors for leaf areas are 10 to 20%. Bole biomass estimation accounts for most of the error for biomass, while estimation of branch characteristics and area/weight ratios accounts for the leaf area error. Error analysis provides insight for cost effective design of future analyses. Predictive equations for biomass and leaf area, with empirically derived estimators of prediction error, are given. Systematic prediction errors for small aspen trees and for leaf area of spruce from different site-types suggest a need for different predictive models within species. Predictive equations are compared with published equations; significant differences may be due to species responses to regional or site differences. Proportional contributions of component biomass in aspen change in ways related to tree size and stand development. Spruce maintains comparatively constant proportions with size, but shows changes corresponding to site. This suggests greater morphological plasticity of aspen and significance for spruce of nutrient conditions. Author

N87-24736*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TEN YEAR CHANGE IN FOREST SUCCESSION AND COMPOSITION MEASURED BY REMOTE SENSING
Forrest G. Hall, Daniel B. Botkin, Donald E. Strebel, Kerry K. Woods, and Scott J. Goetz (Science Applications, Inc., Greenbelt, Md.) 15 Apr. 1987 22 p
(Grant NAG5-548)
(NASA-CR-180948; NAS 1.26:180948) Avail: NTIS HC A02/MF A01 CSCL 02F

Vegetation dynamics and changes in ecological patterns were measured by remote sensing over a 10 year period (1973 to 1983) for 148,406 landscape elements, covering more than 500 sq km in a protected forested wilderness. Quantitative measurements were made possible by methods to detect ecologically meaningful landscape units; these allowed measurement of ecological transition frequencies and calculation of expected recurrence times. Measured ecological transition frequencies reveal boreal forest wilderness as spatially heterogeneous and highly dynamic, with one-sixth of the area in clearings and early successional stages, consistent with recent postulates about the spatial and temporal patterns of natural ecosystems. Differences between managed forest areas and a protected wilderness allow assessment of different management regimes. Author

N87-24737*# Aster Consulting Associates, Inc., La Jolla, Calif.
INVERSION OF CANOPY REFLECTANCE MODELS FOR ESTIMATION OF VEGETATION PARAMETERS Final Report
Narendra S. Goel 15 Jun. 1987 20 p

(Contract NAS5-29472)
(NASA-CR-181059; NAS 1.26:181059) Avail: NTIS HC A02/MF A01 CSCL 02F

One of the keys to successful remote sensing of vegetation is to be able to estimate important agronomic parameters like leaf area index (LAI) and biomass (BM) from the bidirectional canopy reflectance (CR) data obtained by a space-shuttle or satellite borne sensor. One approach for such an estimation is through inversion of CR models which relate these parameters to CR. The feasibility of this approach was shown. The overall objective of the research carried out was to address heretofore uninvestigated but important fundamental issues, develop the inversion technique further, and delineate its strengths and limitations. Author

N87-24738# European Space Agency, Paris (France).
PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON PROGRESS IN IMAGING SENSORS
B. Battrick, ed. and E. J. Rolfe, ed. Nov. 1986 663 p In ENGLISH, FRENCH, and GERMAN Proceedings held in Stuttgart, West Germany, 1-5 Sep. 1985; sponsored by the International Society for Photogrammetry and Remote Sensing, the Deutsche Gesellschaft fuer Photogrammetrie und Fernerkundung, DGLR, ESA, and DFVLR Submitted for publication Original contains color illustrations
(ESA-SP-252; ISSN-0379-6566; ETN-87-99861) Copyright Avail: NTIS HC A99/MF A01

The complete proceedings of the symposium are presented. Some topics of interest were: Remote sensing image quality; camera calibration; optical data from space; sensor orientation and navigation; microwave data; and imaging spectrometers. Also discussed were: Aerial photography; microwave sensors; acquisition and use of space photographic data; and photogrammetry. For individual titles, see N87-24739 through N87-24815.

N87-24739*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
EARTH SURFACE SENSING IN THE '90'S
Charles Elachi *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 1-11 Original document contains color illustrations Sponsored by NASA (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01 CSCL 08B

Advances in Earth sensor technology and data handling techniques are reviewed. These will allow the acquisition of high resolution images over a wide range of the electromagnetic spectrum (from microwave to optical) with sufficient spectral resolution to permit detailed analysis of the surface chemical, thermal, and physical properties. When combined with the topography, this will allow the user to analyze the full data set in a perspective view that enhances interpretation capability. ESA

N87-24740# Stuttgart Univ. (West Germany). Inst. for Navigation.
SMART SENSORS: AN OVERVIEW AND SELECTED EXAMPLES
M. J. Nahvi and Ph. Hartl *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 13-22 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

Smart sensors are reviewed and three conceptual levels are recognized, defining a functional hierarchy: data improvement, to increase accuracy; information extraction, to reduce data rate, and decision, to produce autonomy. Applications in measurement, control, remote sensing, and autonomous systems are illustrated, and advantages are quantified. Onboard processing for data reduction and autonomy is the trend in remote sensing and space missions, requiring intelligence, a knowledge base, and models of the external world. The role of smart sensors in an intelligent system is discussed and the extent of its operation is defined. Parallels with living compound lens and eye are observed. ESA

N87-24741# Stuttgart Univ. (West Germany).
IMPROVEMENT OF IMAGE QUALITY BY FORWARD MOTION COMPENSATION, A PRELIMINARY REPORT **c35**
Friedrich Ackermann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 25-32 (For primary document see N87-24738 18-43)
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Aerial photographs with and without forward motion compensation were compared. Measuring precision and geometrical accuracy in plan and height, and image quality as expressed by transfer functions were studied. Results confirm that air survey cameras with linear compensation of the forward motion during exposure permit longer exposure times and high resolution films. The direct result is visibly improved resolution, better image interpretation, and better measuring precision. ESA

N87-24742# Physikalisch-Technische Bundesanstalt, Brunswick (West Germany).
OPTICAL TRANSFER FUNCTION (OTF)-BASED QUALITY CRITERIA FOR AERIAL CAMERAS AND IMAGING SYSTEMS
K.-J. Rosenbruch *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 33-37 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

It is demonstrated how for optical systems and imaging sensors, the optical transfer function can be reduced and used in practical application. For an image quality criterion (IQC) and data reduction, instead of the modulation transfer function (MTF) curve, the integral value is a reasonable data reduction. This integral should be extended up to the intersecting point of the total MTF curve of the receiver. If a correlation between quality numbers and the subjective impression of photographs is required, the just recognizable quality steps are proportional to the logarithm of a given integral. For the evaluation of the information content and digital image processing, the total MTF and relevant threshold modulation curves are important but not the integrals or log of integrals. The kind of object or its spatial frequency spectrum is not to be taken into account in an IQC evaluation. ESA

N87-24743# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Section.
THOUGHTS ON A STANDARD ALGORITHM FOR CAMERA CALIBRATION **c35**
Hartmut Ziemann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 41-48 (For primary document see N87-24738 18-43)
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Starting from concerns related to the calibration of aerial cameras, aspects of standardization of camera calibration procedures are discussed. These include standardization activities and a possible role of the International Society for Photogrammetry and Remote Sensing in such activities, a definition of the term camera calibration, and a mathematical model and an algorithm for camera calibration. The mathematical model includes special considerations for cameras with adjustable focus. ESA

N87-24744# Xian Research Inst. of Surveying and Mapping (China).
APPLIED FORMULAE FOR CALIBRATION OF AERIAL PHOTOGRAMMETRIC CAMERAS **c35**
Wang Yuwei *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 49-54 (For primary document see N87-24738 18-43)
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Formulas for calibrating the inner orientation of aerial photogrammetric cameras, and to estimate its accuracy are given. The calculation accuracy is enhanced in determining principal point position and focal length by iteration in which the influences of distortion and scale line errors of calibration plate are taken into consideration. There are no restrictions on scale line errors of calibration plate. Theoretically, any calibration plates with low accuracy of scale lines in terms of nominal sizes can be used, if they are calibrated accurately. The obtained principal point and

focal length agree with those in the literature. Their values are the weighted averages of those determined by pairs of points on the axes of image plane, so that photogrammetric accuracy benefits from the application of the parameters. Each calculated parameter has its own error estimate. ESA

N87-24745# Bonn Univ. (West Germany). Inst. of Photogrammetry.
GEOMETRICAL SYSTEM CALIBRATION, ESPECIALLY FOR METRIC AERIAL CAMERAS **c35**
G. Kupfer *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 55-62 (For primary document see N87-24738 18-43)
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Geometrical system calibration is defined and its history is reviewed. Practical considerations and desirable capabilities of a calibration algorithm are discussed. Problems of full and partial system calibration are shown and recommendations for geometrical system calibration are given. Possibilities of the procedure are shown by examples. ESA

N87-24746# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
COMPARATIVE ANALYSIS OF THEMATIC MAPPER AND SPOT IMAGE DATA FOR LAND USE INVFSTIGATION
W. Kirchhof, W. Mauser, and H. J. Stibig *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 65-71 Prepared in cooperation with Freiburg Univ.(West Germany). Original document contains color illustrations (For primary document see N87-24738 18-43)
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Data records including 10, 20, 30, 50, and 80 m pixels from a Thematic Mapper (TM) simulation were analyzed regarding information content. Discrimination of objects, structures, and textures as a function of pixel size and combination of spectral bands is investigated by visual interpretation and supervised classification for applications in agriculture and forestry. New TM bands bring extensive improvement in separating areas of vegetation and built-up areas and in delimiting growth and moisture states. The TM is suited for extracting thematic information of surface areas of 1 hectare or more, 3 to 4 spectral bands are normally sufficient. The information content of the 20 m SPOT multiband data does not differ from that of comparable TM bands (TM2, TM3, TM4). Structural and textural contents of the panchromatic 10 m SPOT band form a substantial complement to the TM information. ESA

N87-24747# IBM France S. A., Paris. Science Center.
TOWARDS AN AUTOMATIC IDENTIFICATION OF URBAN TEXTURES [VERS UNE IDENTIFICATION AUTOMATIQUE DES TISSUS URBAINS]
M. Armand and M. Hernandez *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 73-85 In FRENCH; ENGLISH summary Original document contains color illustrations (For primary document see N87-24738 18-43)
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Use of LANDSAT-5 Thematic Mapper imagery in urban planning and management was investigated. Urban structures and textures were analyzed, and the methodology of the photointerpreter was simulated. The radiometric properties were used for two types of Bayesian classifications: a general classification to identify the large homogeneous entities of the image, and a classification of primitives (urban, vegetation, streets). A moving window was applied to determine the percentage for each primitive contained in the corresponding homogeneous entity. Results were compared with existing urban cartography. The semiautomatic classification method works well, even if the division into zones is rather rough. ESA

N87-24748# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany).
APPLICATION OF MODULAR OPTOELECTRONIC MULTISPECTRAL SCANNER (MOMS) DATA TO HYDROLOGY AND VEGETATION STUDIES. TEST SITE: PANTANAL REGION (BRAZIL/PARAGUAY)
Hermann J. H. Kux, Martin Hauck, and Konrad Hiller *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 87-90 Prepared in cooperation with Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil) (For primary document see N87-24738 18-43)
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A section of Brazil/Paraguay/Bolivia imaged by MOMS was digitally classified and merged with a Thematic Mapper scene from the same region. A test of consistency and correctness was applied to the digital classifications of both sensors using kappa (k) statistics. Considering that the k value obtained is very low (0.1202), there is no agreement between the results of MOMS and TM classifications. The classification matrix shows a high confusion among the classes dense vegetation and wetlands. Areas covered by dense vegetation were interspersed with and/or overlayed with areas of wetlands with different water content. This great variation of soil moisture seems to be the principal environmental factor responsible for the high confusion found in these thematic classes. ESA

N87-24749# Stuttgart Univ. (West Germany).
THE USE OF CAMERA ORIENTATION DATA IN PHOTOGRAMMETRY: A REVIEW **c35**
Friedrich Ackermann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 93-99 (For primary document see N87-24738 18-43)
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It is shown that precise camera orientation data obtained from flight navigation systems are of greatest importance to aerial photogrammetry, with regard to geometrical accuracy and economy. The first application of navigation systems concerns real time flight navigation and pinpoint photography to obtain regular overlap. The requirements can be met by any high precision navigation system. The most immediate use of recorded and postprocessed orientation data is in combination with aerial triangulation which would become practically independent of ground control points. Only position data are needed. The accuracy requirements are high but can potentially be met by GPS phase measurements. The accuracy requirements for direct setting of orientation parameters of photographs or pairs of photographs, avoiding aerial triangulation of reference to ground control, are extremely high and cannot yet be met by navigation systems. ESA

N87-24750# Stuttgart Univ. (West Germany).
THE EFFECTS OF CAMERA POSITION AND ATTITUDE DATA IN AERIAL TRIANGULATION, A SIMULATION STUDY **c35**
Peter Friess *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 101-111 (For primary document see N87-24738 18-43)
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Accuracy attainable in aerial triangulation using navigation data in joint block adjustment was studied in simulations. The influence of camera position data on the accuracy of photogrammetric blocks is considerable. They always allow reduction of control to the minimum case with four ground control points in the corners of the block. Camera position coordinates observed with low accuracy (10 m) allow aerial triangulation with minimum ground control and provide ground point position accuracies which could otherwise only be reached with quite dense ground control. Precise attitude data combined with camera position data provide an additional improvement of block adjustment. The use of precise measured rotations alone combined with sparse ground control (two control point chains) is also possible. ESA

N87-24751# National Aerospace Lab., Amsterdam (Netherlands).
A MODULAR AND VERSATILE ACQUISITION, RECORDING AND PREPROCESSING SYSTEM FOR AIRBORNE REMOTE SENSING
H. Pouwels and L. J. Aartman *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 113-121 (For primary document see N87-24738 18-43)
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An aircraft which can be equipped with either a SLAR, a multispectral scanner, or a TV-based scanner is described. The airborne recording equipment is designed to accommodate these various sensors. The general airborne system setup is: the sensor, a dedicated digitizing unit, and an interface to a high density digital tape recorder. Aircraft parameters like position, attitude, and time are recorded on the same tape. Flight tapes are replayed on existing equipment as used for PCM encoded telemetry data; only a high bit rate decoding unit is added. Raw remote sensing data and flight data are transfered to computer tapes. The software system Preprocessing Airborne Remote Sensing performs radiometric and geometric corrections for aircraft motion and for sensor characteristics. ESA

N87-24752# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Wesseling (West Germany). Inst. for Optoelectronics.
INFRARED EARTH HORIZON SENSOR CONCEPTS IN VARIOUS SPECTRAL BANDS
Siegfried Craubner and Rudolf Richter *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 123-127 (For primary document see N87-24738 18-43)
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Concepts for infrared Earth horizon sensors operating in different spectral bands are presented. Besides the 14 to 16 micron CO2 band currently used, the 9.4 to 9.8 micron ozone band and the 20 to 22 micron water vapor band are suitable for horizon detection. Measurements in the ozone band would allow a smaller optics aperture than in the CO2 band. The advantage of the water vapor band is a horizon nearer to the Earth's rim and a lower variation of the horizon radiance profile for the different standard atmospheres. Using commercially available metal/thermistor bolometers or pyroelectric detectors, the signal to noise ratio in the bands 9.4 to 9.8, 14 to 16, and 20 to 22 microns can be made sufficient. Thus there is no need to use cooled detectors in this application. ESA

N87-24753# Khartoum Univ. (Sudan).
OPTICAL AND DIGITAL SAR PROCESSING TECHNIQUES: A STATISTICAL COMPARISON OF ACCURACY USING SEASAT IMAGERY **c74**
Abdalla Elsadig Ali *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 131-139 (For primary document see N87-24738 18-43)
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Geometric accuracy of SEASAT synthetic aperture orbital radar images was tested. Each of four images was processed using different SAR processing systems and methodologies. Image coordinates of selected points were measured and transformed to the terrain system using mathematical transformations. Comparison of the known terrain coordinates and the transformed image coordinates of these points on each image allowed various statistical characteristics to be derived and showed the capability of each of the processing systems tested in producing accurate SAR images. Results show that application of an affine transformation can substantially eliminate differential scale errors in optically processed images. Error magnitude in digitally processed images are much lower, and differential scale errors are eliminated. ESA

N87-24754# Technische Univ., Hanover (West Germany). Inst. for Photogrammetry and Engineering Surveys.
INTRODUCTION OF GEOMETRIC INFORMATION TO RADAR IMAGE DATA
G. Konency and W. Schuhr *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 141-147 (For primary document see N87-24738 18-43)
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To improve the geometric accuracy of initial radar image data, the introduction of additional geometric information to radar image data, e.g., ground control point coordinate values, terrain heights, and information about the behavior of the sensor is described. The derived formulas and practical results, especially for a more precise slant to groundrange conversion process, are suggested to serve the user with geometrically more precisely corrected basic SAR image data. ESA

N87-24755# Marconi Co. Ltd., Great Baddow (England).
THE EFFECT OF RECEIVER AMPLIFIER NON-LINEARITY ON ERS-1 SYNTHETIC APERTURE RADAR IMAGERY **c32**
J. J. W. Wilson *In* ESA Proceedings of the International Symposium of Progress in Imaging Sensors Nov. 1986 p 149-155 Sponsored by ESA (For primary document see N87-24738 18-43)
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The effect of a nonlinear active microwave instrument (AMI) receiver system gain characteristic on ERS-1 synthetic aperture radar imagery is assessed by feeding the signal from a point target on a distributed target background together with thermal noise into the receiver system. The output from the receiver system is then subjected to range and azimuth compression in order to generate the image intensity at the point in the image corresponding to the peak of the point target response function. The impact of nonlinearity and saturation in the AMI receiver system transfer characteristic are assessed by comparing the image intensity arising from passing the input signal through the AMI receiver system with the image intensity arising from passing the same input through a similar but completely linear receiver system. ESA

N87-24756*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
RADIOMETRIC CALIBRATION OF THE SHUTTLE IMAGING RADAR (SIR-C) SYSTEM
John C. Curlander *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 157-160 Sponsored by NASA (For primary document see N87-24738 18-43)
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The radiometric calibration accuracy of the Shuttle Imaging Radar (SIR-C) sensor is discussed. The analysis includes the antenna, RF electronics, the digital data handling system, the platform attitude control, attitude determination accuracy, and orbit effects. The radiometric distortion of the image products by the ground processing system used for the image formation is also considered. Since the SIR-C system is a dual-frequency quad-polarized system (i.e., 8 channels), the amplitude and phase error is considered over all possible operating modes and environments for absolute and relative (long-term and short-term) calibration within a channel and across channels. ESA

N87-24757# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Div. of Physics.
PROPOSED CHANGES TO THE CANADIAN CAMERA CALIBRATION REPORT **c35**
H. Ziemann, M. L. Landreville, and J. E. W. Plummer *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 163-169 (For primary document see N87-24738 18-43)
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The requirements for an aerial survey camera are discussed, and Canadian camera calibration reports are reviewed. The reports are based on the requirements stated in the Canadian federal Specification for Aerial Survey Photography; changes in the Specification resulted at a number of times in changes to the calibration report. A large number of items included at one time or another are explained. A proposal indicating which items should

be retained during a major revision of the calibration report, and which new items should be added, is made. ESA

N87-24758# Munich FAF Univ., Neubiberg (West Germany).
INTERIOR ORIENTATION STABILITY OF A PARTIAL METRIC CAMERA, AN EXPERIMENTAL STUDY **c35**
J. Peipe *In its* Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 171-178 (For primary document see N87-24738 18-43)
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The interior orientation stability of a partial metric camera, Rolleiflex SLX Reseau, was investigated. Comparison of simultaneous calibrations within a bundle adjustment shows that precise results are obtainable only by using a self-calibration approach. The simultaneously derived elements of interior orientation may serve as initial values for a subsequent bundle adjustment. Reproducibility is + or - 50 microns for the principal distance and + or - 30 microns for the coordinates of the principal point. For an unchanged camera body-lens combination a stability of + or - 20 microns referring to all coordinates of the projective center is achievable. ESA

N87-24759# Joensuu Univ. (Finland). Dept. of Physics.
GONIOMETER FOR CALIBRATION OF SYSTEM AND OTHER SMALL CAMERAS **c35**
J. Hakkarainen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 179-184 (For primary document see N87-24738 18-43)
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A horizontal goniometer for calibration and determination of optical characteristics of system and other small cameras was constructed. The principle is similar to the old goniometers of Wild and the HUT, but the technical solutions are more modern. Eight different characteristics of the lens can be determined. Examples of test results are given. ESA

N87-24760# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
ENVIRONMENTAL CONDITIONS AND CALIBRATION OF THE SPACELAB METRIC CAMERA **c35**
M. Schroeder *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 185-190 (For primary document see N87-24738 18-43)
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A metric camera of 305 mm focal length was flown in the First Spacelab Mission on Space Shuttle Flight 9. Technical details on the installation of the camera, environmental conditions inside Spacelab, and calibration data of the camera are presented. ESA

N87-24761# Institut Geographique National, Paris (France).
APPLICATIONS OF LASER AIRBORNE TELEMETRY AT INSTITUT GEOGRAPHIQUE NATIONAL (IGN), FRANCE **c17**
R. Brossier *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 193-199 (For primary document see N87-24738 18-43)
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An airborne system on pressurized aircraft for the determination of ground profiles to provide an altimetric network for small scale photogrammetric surveys was developed. The system includes a laser telemeter for measuring the distance between aircraft and ground, and a pressure sensor for obtaining an isobaric reference. From this initial version, a system was developed to synchronize laser emission with photograph exposures. Another application concerns determination of ground profiles in wooded areas, which implies a modification of laser reception, for receiving all the echos coming from the ground. The ground profile itself is determined by sampling of the data. ESA

N87-24762# New Brunswick Univ., Fredericton. Geodetic Research Lab.
GLOBAL POSITIONING SYSTEM (GPS) POSITIONING TECHNIQUES FOR MOVING SENSORS **c04**
Alfred Kleusberg *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 201-205 Sponsored by the Canadian Natural Sciences and Engineering Research Council (For primary document see N87-24738 18-43)
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A precise positioning technique for moving platforms was developed utilizing measurements of the Global Positioning System (GPS) signals. The standard relative positioning accuracy of 10 to 20 m based on pseudo ranges is improved to the submeter level by including carrier signal Doppler observations. The processing algorithm is described. Two sets of results obtained from dual frequency observations with TI-4100 GPS receivers are presented. The first set pertains to a kinematic treatment of static mode observations of a 40 km baseline and is used to assess the accuracy of the approach by comparing with external standards. The second set is based on observations made on a truck repeatedly driving along a presurveyed route and a simultaneously operating GPS monitor station at a distance of 95 km. Results of the test data sets prove the ability of GPS to provide submeter positioning accuracy for moving platforms. ESA

N87-24763# Stuttgart Univ. (West Germany). Inst. for Navigation.
APPLICATION OF GLOBAL POSITIONING SYSTEM (GPS) RECEIVERS FOR EARTH OBSERVATION **c04**
Ph. Hartl and W. Schoeller *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 207-214 (For primary document see N87-24738 18-43)
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Use of the Global Positioning System (GPS) to acquire navigational information is proposed. The extremely high relative accuracy of a few dm over several hundred kilometers can be achieved in positioning, if the carrier phase measurement is applied in connection with the differential mode. The carrier phase signals can be used for attitude measurements. Here an interferometer system must be used, which consists of at least three antennas and corresponding receivers. They must constitute a pair of orthogonal interferometers. Relative accuracies on the order of fractions of a degree down to several arcseconds might be achieved. ESA

N87-24764# Stuttgart Univ. (West Germany). Inst. for Navigation.
COORDINATE TRANSFORMATION PROCEDURES FOR GLOBAL POSITIONING SYSTEM (GPS) ATTITUDE CONTROL **c04**
Ph. Hartl and A. Wehr *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 215-226 (For primary document see N87-24738 18-43)
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It is shown that it is possible to determine attitude from two Global Positioning System (GPS) interferometrical measurements to two different GPS-satellites. The direction of the instantaneous position of a GPS-satellite (NAVSTAR-1) can be determined from carrier phase measurements with an interferometer set-up consisting of at least three antennas. If the direction is also measured to a second NAVSTAR, then the platform of the interferometer is defined in its three-dimensional orientation with respect to the plane defined by the instantaneous positions of NAVSTAR-1, NAVSTAR-2 and center of interferometer platform. With proper coordinate transformations the platform's orientation in any other coordinate system can be defined. ESA

N87-24765# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
DEFINITION OF A THERMAL INFRARED PUSHBROOM IMAGER FOR EARTH OBSERVATION
M. Rast, M. L. Reynolds, and P. Hollier (MATRA Espace, Toulouse, France) *In its* Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 229-234 (For primary document see N87-24738 18-43)
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The feasibility of a thermal IR pushbroom camera design to satisfy the high resolution, multispectral imaging requirement corresponding to Earth observation mission objectives was assessed. In view of the state of the art, it seems that such an instrument is feasible within the next decade. According to a scientific and user requirement inquiry, the suggested ground resolution of 30 m could be reduced to 50 m while maintaining the main mission objectives and requirements. This reduction would relax the technical and cost problems for a spaceborne instrument. For example, it is estimated that the mass would reduce from 320 kg to 120 kg and diminish the maximum dimensions from 3.0 m to 1.7 m due to an entrance aperture reduction from 500 mm to 250 mm. ESA

N87-24766# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Space Systems Group.
ADVANCED IMAGING SPECTROMETER FOR OCEAN COLOR/FLUORESCENCE MEASUREMENTS AND FURTHER APPLICATIONS c19
B. Kunkel, F. Blechinger, R. Lutz, and H. Winkenbach *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 237-246 (For primary document see N87-24738 18-43)
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A spaceborne chlorophyll fluorescence imaging spectrometer is proposed. The instrument is suitable also for a variety of other applications, especially as an airborne version. The technical concept is based on an all-reflective optics system and a 1024 sq matrix CCD detector array. The imaging spectrometer is designed to cover a spectral range from 425 to 960 nm in resolution steps of 5 nm per channel at 0.06 % albedo resolution. It provides 108 spectral channels. The FOV amounts to + or - 16.2 deg at 300 m ground pixel size. This corresponds to 1024 pixels in the spatially scanned (cross track) direction. Since no frame-transfer matrix CCD array with 1024 sq pixels is available, the initiated airborne version uses 512 sq. ESA

N87-24767# Canada Centre for Remote Sensing, Ottawa (Ontario).
THE MULTIDETECTOR ELECTRO-OPTICAL IMAGING SENSOR (MEIS) 2 PUSHBROOM IMAGER: FOUR YEARS OF OPERATION c74
S. M. Till, R. A. Neville, W. D. McColl, and R. P. Gauthier *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 247-253 (For primary document see N87-24738 18-43)
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A linear array multispectral airborne imager was designed to provide remote sensing data with improved radiometric and geometric characteristics, and with spectral selectivity for specific applications. Four years of operation, acquiring digital imagery for 50 airborne missions per year, provided unique data from this state-of-the-art imager, for application research and for sensor evaluation. Ongoing sensor development includes optics for continuous fore-aft stereo data acquisition, calibrated narrow band (3 nm) spectral filter sets, integration of downwelling irradiance and radiance spectral data, interference filters free from spectral blue shift, and an automated laboratory calibration facility. ESA

N87-24768# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
THE STEREO PUSHBROOM SCANNER SYSTEM DIGITAL PHOTOGRAMMETRY SYSTEM (DPS) AND ITS ACCURACY c74
Otto Hofmann *In* ESA Proceedings of the International Symposium on Progress in Imagery Sensors Nov. 1986 p 257-264 Previously announced as N87-17167 (For primary document see N87-24738 18-43)
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A digital stereoscanner with three line sensor arrays working on the pushbroom principle and a suitable rigorous compilation process, was designed. It delivers the orientation data of the camera in selectable update points along the flight path of aircraft, spacecraft, or missiles, the three-dimensional coordinates of the digital elevation model, ortho and stereo-orthophotos, digital elements for line maps and rectified multispectral images. By computer simulated operational models the influence of the camera and flight parameters on the accuracy of the models was tested. ESA

N87-24769# Technische Univ., Hanover (West Germany). Inst. for Photogrammetry and Engineering Surveys.
AERIAL TRIANGULATION OF CCD LINE-SCANNER IMAGES
E. Kruck and P. Lohmann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 265-270 (For primary document see N87-24738 18-43)
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A method for the evaluation of CCD line scanner imagery is presented. The mathematical formulation considers central perspective geometry within a single line and allows easy implementation on analytical photogrammetric systems. The adjustment allows the use of additional frame camera images as well as other measurements. An anchor point file for the generation of orthophotos may be generated whenever digital terrain model data are available. Results using a combined adjustment of Spacelab Metric Camera photographs and MOMS data are presented. ESA

N87-24770# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
A COMMON APPROACH TO NAVIGATION AND GEOMETRIC IMAGE CORRECTION FOR THE STEREOSCOPIC LINESCAN CAMERA MEOSS (MONOCULAR ELECTRO-OPTICAL STEREO SCANNER)
A. Drescher, M. Lehner, and J. Wu *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 271-278 (For primary document see N87-24738 18-43)
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A photogrammetric triangulation scheme to analyze geometric image distortions of threefold stereoscopic linescan cameras is presented. Comparison with conventional block adjustment for photographic frame cameras indicates two problem areas: high frequency disturbances of the carrier and a resonance effect. Mathematical models of satellite dynamics help to stabilize the estimation process. This is discussed with the example of the Indian/German MEOSS project and it is also shown that inversely the actual satellite dynamics can be inferred from analysis of the image distortions. ESA

N87-24771# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
INVESTIGATION OF SIMULATED MONOCULAR ELECTRO-OPTICAL STEREO SCANNER (MEOSS)-IMAGERY FOR SENSOR NAVIGATION AND TERRAIN DERIVATION
J. Wu *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 279-284 (For primary document see N87-24738 18-43)
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Rectification of Monocular Electro-Optical Stereo Scanner images for distortions due to perturbations of position and attitude parameters and elevation differences in the terrain is discussed. Analytical photogrammetry is applied to evaluations of the stereoscopic image data. Primary results are the sensor orientation and the terrain model. The digital image processing system includes a photogrammetric aerial triangulation program based on collinearity conditions and weight constraints. Numerical simulation reveals the potential usage of such a sensor system concerning sensor navigation and terrain derivation. ESA

N87-24772# Agfa-Gevaert N.V., Mortsel (Belgium). Graphic Systems Div.
THE AVIPHOT PAN 50 PE FILM c35
H. VandePoel and W. Liekens *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov.

1986 p 288-293 (For primary document see N87-24738 18-43)
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Black and white film for aerial photogaphy of low contrast areas from low to high altitudes is described. The extended red sensitivity, the high resolving power, the very fine grain, the extreme ability to control contrast variation, and the physical properties of the film are the basic elements of the quality attained in applications such as aerial survey and reconnaissance flights. ESA

N87-24773# Xian Research Inst. of Surveying and Mapping (China).
ON THE MATCHING OF RESOLUTION IN AERIAL PHOTOGRAPHIC SYSTEMS c35
Junliang Cai and Huiping Chen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 295-302 (For primary document see N87-24738 18-43)
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Matching of lens and film resolutions and image motion is discussed. A matching when the resolution of film is 3 to 4 times higher than that of lens with the image motion less than 2/3 to 3/4 of line pair width of static resolution is best. In order to improve the dynamic resolution, it is more effective to limit the image motion than to improve the static resolution. Therefore, the use of image motion compensation is necessary. In this case, the static resolution 3 to 4 times higher than the resolution corresponding to residual image motion is preferable. ESA

N87-24774# Institut Geographique National, Paris (France).
INSTITUT GEOGRAPHIQUE NATIONAL (IGN), FRANCE: PARTICIPATION IN SPACELAB PHOTOGRAPHIC TEST CAMPAIGN c35
R. Charton *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 303-309 (For primary document see N87-24738 18-43)
Avail: NTIS HC A99/MF A01

To prepare for the next Spacelab flight Zeiss RMK cameras equipped with a forward motion compensation and emulsions of high definition but low sensitivity were assessed. In order to test a maximum of conditions met by Spacelab, test flights considered several parameters, such as Sun elevation and altitude of the aircraft in relation with V/H ratios. Data exploitation includes a sensitometric study of the films in order to evaluate contrast, granularity, and sensitivity of each emulsion and to determine resolving power for various incident angles. ESA

N87-24775# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
EXPOSURE TEST WITH HIGH RESOLUTION FILMS FROM HIGH ALTITUDE
M. Schroeder and C. Duda *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 311-316 (For primary document see N87-24738 18-43)
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High altitude (10 km) aerial photographs on high resolution films (3412 b/w); SO-131 (CIR); SO-242 (Co) taken at various illumination conditions and with different exposure settings were analyzed by densitometric measurements in order to find the influence of exposure and illumination on film density. From these measurements, formulas for exposure settings as function of the Sun elevation were derived. ESA

N87-24776# Firma Maps G.m.b.H., Munich (West Germany).
VERY HIGH RESOLUTION AERIAL FILMS c35
Rolf Becker *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 317-326 (For primary document see N87-24738 18-43)
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The use of very high resolution aerial films in aerial photography is evaluated. Commonly used panchromatic, color, and CIR films and their high resolution equivalents are compared. Based on practical experience and systematic investigations, the very high image quality and improved height accuracy that can be achieved using these films are demonstrated. Advantages to be gained from this improvement and operational restrictions encountered when using high resolution film are discussed. ESA

N87-24777# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
THE FIRST ESA REMOTE SENSING SATELLITE (STATUS AND OUTLOOK) c18
Hans Martin Braun and Erich H. Velten *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 329-334 (For primary document see N87-24738 18-43)
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The ERS-1 satellite design and development status are outlined. Mission objectives concentrate on ocean monitoring for scientific and economic purposes. The core payload consists of the active microwave instrumentation containing a synthetic aperture radar and a microwave scatterometer, and a radar altimeter. Supplementary instruments are an along track scanning radiometer, a microwave sounder, a precise range and range rate experiment, and a laser retroreflector. ESA

N87-24778# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
X-SAR: A SHUTTLE-BORNE X-BAND SYNTHETIC APERTURE RADAR c32
Wolfgang Gilg and David Miller *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 335-339 (For primary document see N87-24738 18-43)
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The X-band SAR to fly with SIR-C in a multispectral dual polarized SAR experiment is introduced. The mechanical and electrical configurations are described, and the results of performance prediction analysis are assessed. For the nominal orbit altitude of 255 km X-SAR will provide a geometrical resolution within 30 m in range and azimuth and a swath width of 15 to 34 km. The instantaneous dynamic range of the measurements will be 20 dB, with an additional adjustable bias up to 40 dB. In order to adapt the instrument to the different geometrical conditions, several parameters are selectable from ground: pulse repetition frequency (1.2 to 1.8 kHz), position and length of the echo window, echo quantization bit number, and the transmit pulse chirp bandwidth. ESA

N87-24779# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
MILLIMETER-WAVE ATMOSPHERIC SOUNDER (MAS) FOR USE ON THE SPACE SHUTTLE c19
W. Fricke *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 341-344 Prepared in cooperation with Max-Planck Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany, Bern Univ., Switzerland, and the Naval Research Lab., Washington DC (For primary document see N87-24738 18-43)
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The microwave atmospheric sounder (MAS) remote sensor for passive sounding of the Earth's atmosphere from the Space Shuttle is described. Millimeter wave radiation emitted by the atmosphere in the height range between 20 and 100 km is measured at 62, 184, and 204 GHz. The MAS data yield direct information about the distribution of temperature, pressure, water vapor, ozone, and chlorine monoxide in the stratosphere and mesosphere, in the latitude ranges between + 45 deg or + 74 deg, depending on the Shuttle mission (28 or 57 deg inclination), assuming a circular orbit of 300 km altitude. The MAS can be regarded as an early warning system for important environmental problems, e.g., the possible man made destruction of the ozone layer. ESA

N87-24780# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Section.
THE ROLE OF GOVERNMENT SPECIFICATIONS IN AERIAL PHOTOGRAPHY c35
Hartmut Ziemann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 351-353 (For primary document see N87-24738 18-43)
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It is indicated that the introduction and periodic review of a Specification for Aerial Survey Photography is helpful in achieving a fairly high and consistent quality in the aerial photography acquired by contractors for the needs of the Canadian federal government by forcing good contractor performance and by occasionally requiring modifications to or the replacement of aerial survey cameras. The interaction between the Canadian regulating and controlling agency, the camera manufacturers, and contractors proves beneficial to all parties. ESA

N87-24781# Zeiss (Carl), Oberkochen (West Germany).
THE RMK AERIAL CAMERA SYSTEM: PERFORMANCE POTENTIAL OF AERIAL PHOTOGRAPHY WITH FORWARD MOTION COMPENSATION **c35**
W. Lorch *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 363-366 (For primary document see N87-24738 18-43)
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It is shown that the use of forward motion compensation (FMC) in aerial survey cameras increases the image quality significantly. Medium-resolution films are mostly being used with FMC. Another considerable image quality increase can be achieved by the use of high-resolution films which were not very suited for large-scale photography because of their high contrast. Performance is optimum with the lens stepped down 1 stop. Experience shows that an adverse residual image motion due to unfavorable external influences does not occur if exposure times of 1/300 sec or less are used. ESA

N87-24782# Wild Heerbrugg Ltd. (Switzerland).
WILD AVIOPHOT (TM) RC20 AERIAL CAMERA SYSTEM. THE OTHER APPROACH TO IMAGE MOTION COMPENSATION IN AERIAL PHOTOGRAPHY **c35**
Arthur Rohrbach and Roland Schlienger *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 367-373 (For primary document see N87-24738 18-43)
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It is shown that the integration of forward motion compensation (FMC) in the Wild Aviophot RC20 aerial camera system, allows a better exploitation of the high inherent optical performance of the Wild lenses. The main practical benefits are: an increase in image quality and resolution when combining the FMC device of the EC20 with high-resolution emulsions; as well as a better use and exploitation of the standard film types, in connection with large-scale and very-large-scale photographs, under less than ideal light conditions (low light-level). Given the high investment and running costs involved in aerial photography, features like an increase in image resolution, additional flying hours, high product reliability, and flexible connection to aircraft navigation systems are highly significant for overall mapping economy. ESA

N87-24783# Hansa Luftbild G.m.b.H., Muenster (West Germany).
PRACTICAL EXPERIENCES WITH THE ZEISS FORWARD IMAGE MOTION COMPENSATION (FMC) SYSTEM **c35**
G. Winkelmann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 375-377 (For primary document see N87-24738 18-43)
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The increase in image quality from forward motion compensation is discussed. It is a big help for the stereooperator as well as for the interpreter in their identification and measuring work. The distorted fiducial marks do not create any problems or effect the accuracy. Wide angle photography which is forward motion compensated shows quite often a visible reduction of image quality at the upper and lower sides, the effect of angular image motion which before was integrated in the total image motion. The maximum forward motion compensation speed of the system of 30 mm/sec corresponds at a flying speed of 100 Kn to an image scale of 1:1700. At large scales this maximum speed can be reached or exceeded even with fairly slow piston engine aircraft. Another limitation is the fact that a rotating shutter cannot be opened at any time but only at certain periodic intervals. ESA

N87-24784# Technische Univ., Hanover (West Germany). Inst. for Photogrammetry and Engineering Surveys.
PHOTOGRAMMETRIC DATA ACQUISITION USING THE DIGITAL RESEAU-SCANNING SYSTEM ROLLEIMETRIC RS **c74**
Thomas Luhmann and Wilfried Wester-Ebbinghaus *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 381-384 (For primary document see N87-24738 18-43)
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A reseau-scanning imaging system consisting of an A/D conversion device for measurements of analog photographs and a digital camera, is presented. Using reseau-scanning techniques for digital photogrammetric recording, digital images with high resolution and geometric stability can be obtained. ESA

N87-24785# Technische Univ., Berlin (West Germany). Dept. of Photogrammetry and Cartography.
DIGITAL DATA ACQUISITION FOR CLOSE-RANGE PHOTOGRAMMETRY
Joerg Albertz and Alfred Mehlbreuer *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 385-390 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

A digital close-range photogrammetric data acquisition system, suitable for mobile operation and designed to take stereo-images simultaneously is presented. A proposal is made for a high resolution digital acquisition system. By this approach the limited geometrical resolution of CCD-arrays can be improved. Applications with a scanning electron microscope are shown. ESA

N87-24786# Stuttgart Univ. (West Germany). Inst. fuer Photogrammetrie.
CALIBRATION OF CCD VIDEO CAMERAS **c35**
E. Guelch *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 391-403 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

By implementation of CCD video cameras with matrix array sensors in an analytical plotter, a hardware and software system for digital on-line image correlation to be used for conventional photogrammetric measurement was established. Geometric and radiometric calibration of the system is described. Connection of the CCD matrix sensors to the coordinate system of the analytical plotter is highlighted. For geometric and radiometric real time corrections for each pixel, methods for the determination of pixel by pixel or at least of regional correction parameters are discussed. ESA

N87-24787# Karlsruhe Univ. (West Germany). Inst. of Photogrammetry and Topography.
EVALUATION OF A SOLID STATE CAMERA FOR PHOTOGRAMMETRIC APPLICATIONS **c35**
Joachim Wiesel and Thomas Voegtle *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 405-408 (For primary document see N87-24738 18-43)
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A MOS sensor camera was geometrically calibrated by a camera test range. Root mean square errors of a radial-symmetric distortion model are between + or - 10.8 and + or - 13.5 microns in the image plane. The signal to noise ratio of the video data measured in uniform object areas is between + or - 0.5 and + or - 2.5 gray scale values depending on total brightness. Storing images on video tape using a semiprofessional U-matic-video recorder introduces very large, easily observable geometric distortions. ESA

N87-24788# Technische Univ., Dresden (East Germany). Dept. of Geodesy and Cartography.
THE PRODUCTION OF PHOTOGRAPHS OF THE EARTH'S SURFACE TAKEN FROM SATELLITES AND THEIR APPLICATION IN MAP PRODUCTION AND MAP REVISION
Klaus Szangolies *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 411-413 (For primary document see N87-24738 18-43)
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It is shown that photographs taken from space by a camera with 6 spectral channels meet the requirements of most mapping tasks at the scales 1:50,000 to 1:200,000 (and smaller) with regard to the interpretation capability and the geometric accuracy. Advantages compared with the large format aerial cameras lie in the fact that photographs of six different spectral channels are simultaneously obtained, and that the resolving power of the single cameras is considerably higher because of the narrow spectral ranges. ESA

N87-24789# Technische Univ., Munich (West Germany). Inst. fuer Geographie.
LARGE FORMAT CAMERA IMAGE ANALYSIS FOR MAPPING OF LAND USE PATTERNS IN THE REGION NOALE - MUSONE, PO-RIVER-PLAIN, NORTH ITALY
H.-G. Gierloff-Emden *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 415-426 (For primary document see N87-24738 18-43)
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Large Format Camera (LFC)-photography was analyzed to test the applicability of LFC-photographs for topographic and thematic maps. Scales of 1:100,000, 1:50,000 and 1:25,000 were assessed concerning the information and the interpretability of the object-categories, point-shape, line-shape, plane-shape, and the objects in the real world and the discreet signatures in the maps. The minimum visible is analyzed according to ground truth in the test areas. Stereoscopic techniques are not used. Results show that LFC-photography is qualified for topographic maps on the scale of 1:100,000 and 1:50,000 (selected purpose) and for thematic maps up to the scale of 1:25,000 for land use pattern and land surface features. ESA

N87-24790# Technische Univ., Hanover (West Germany). Inst. of Photogrammetry and Engineering Surveys.
GEOMETRIC ASPECTS OF THE USE OF SPACE PHOTOGRAPHS **c35**
Karsten Jacobsen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 427-432 (For primary document see N87-24738 18-43)
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Bundle block adjustments were done with photos taken by the metric camera in Spacelab and the Large Format Camera (LFC). For the block adjustment it is necessary to transform the ground coordinates into an orthogonal coordinate system like a tangential plane to the ellipsoid. Refraction correction formulas based on polynomals are usually not able to describe the refraction also in space. The results of block adjustment with LFC-photos can slightly be improved by a reseau correction of the photo coordinates. The bundle block adjustment and the preparation like refraction, reseau, and Earth curvature correction, transformation of ground coordinates into a tangential plane system and reverse, and also the analysis of the results including plot and covariance analysis was done with the program system BLUH. ESA

N87-24791# Xian Research Inst. of Surveying and Mapping (China).
ESTIMATING PHOTOGRAMMETRIC PRECISION AND CARTOGRAPHIC POTENTIAL OF SPACE IMAGERY
Renxiang Wang *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 433-438 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

Photogrammetric precision and cartographic potential of metric photo and linear array images to be acquired from shuttle or satellite are assessed. The optional overlap of the metric photos for stereoploting is discussed. The 40% overlap may be the best option. The two categories of imagery for photogrammetry and remote sensing are reviewed. ESA

N87-24792# Ludwig-Maximilians-Universitaet, Munich (West Germany). Inst. fuer Geographie.
LARGE FORMAT CAMERA PHOTOGRAPHS OF THE BLACK HILLS, USA, AND THEIR SUITABILITY FOR TOPOGRAPHIC AND THEMATIC MAPPING **c35**
Klaur R. Dietz *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 439-448 In GERMAN; ENGLISH summary (For primary document see N87-24738 18-43)
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Large Format Camera (LCF) photos of the Black Hills, taken on Space Shuttle Mission 41-G, were compared with Metric Camera (MC) photos from the same area, as well as with maps and with high altitude photos. The use of high resolution film, forward motion compensation, and better illumination conditions and base height ratios of the LFC photos give a distinct improvement compared to the MC data. The LFC images seem suitable for mapping on the scale of 1:100,000, if supported by field work. Due to the moderate image quality provided by the EROS Data Center, the production of maps on the scale of 1:50,000 does not seem possible. ESA

N87-24793# International Inst. for Aerial Survey and Earth Sciences, Enschede (Netherlands).
ON THE EQUIVALENT PIXEL-SIZE AND MEANINGFUL BIT-NUMBER OF AIRPHOTOGRAPHS. OPTIMAL SCANNING APERTURE AND DENSITY INCREMENT FOR DIGITIZING AIR PHOTOGRAPHS **c35**
S. A. Hempenius and Jia-bin Xuan *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 451-464 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

The concepts of pixel and bitnumber, borrowed from remote sensing, are applied to airphotographs, to describe the data content in the same manner as in digital image processing. Image sharpness mainly governs the optimal aperture when digitizing an aerial negative. Together with the aperture chosen, emulsion granularity and negative density range determine the number of meaningful bits in the generated digital image data. The data storage capacity of a typical 23 cm x 23 cm sheet of aerial film thus ranges from 10 Mbit (0.03 CCT) to 1 Gbit (4 CCT's) when the aperture is reduced from 0.2 mm to 12 microns. Begond this, a zero-information paradox arises. For reasons of CCT storage economy, optimal presentation, and spatial resolution it is advised to digitize airphotographs with an aperture which yields 4 bits of meaningful data. The method of bit slicing is demonstrated as an effective and user-friendly tool for finding the significant bits. ESA

N87-24794# Technische Univ., Hanover (West Germany). Inst. for Photogrammetry and Engineering Surveys.
DIGITIZATION OF METRIC CAMERA AND LARGE FORMAT CAMERA SPACE PHOTOGRAPHS **c35**
Peter Lohmann and Thomas Luhmann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 465-469 (For primary document see N87-24738 18-43)
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Black and white images of the space shuttle experiments Metric Camera and Large Format Camera were digitized. Investigations show that it is possible to digitize space photographs at an accuracy which corresponds to the resolution of the film. It is demonstrated that the choice of a too small pixel size leads to a loss in the detectability of details within the images because of the apparent film grain. The reseau-scanner Rollei RS1 can cope with the high requirements in terms of geometric accuracy and resolution necessary for photogrammetric applications. ESA

N87-24795# New South Wales Univ., Sydney (Australia). School of Surveying.
GEOMETRIC ASPECTS OF DIGITIZED PHOTOGRAPHY c35
J. C. Trinder *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 471-475 (For primary document see N87-24738 18-43)
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It is shown that for visual observations of digitized photographs such as pointing and interpretation, a pixel size for digitizing of 25 microns is adequate if a marginal reduction in precision of the observations can be tolerated. However, systematic errors resulting from the digitizing process, which are caused by the location of the target in the pattern of pixels are more serious. The rms errors 0.18 x pixel size can be 4 microns in detail position and 10 microns in elevation on photography digitized with pixel sizes of 25 microns. If the high precision of photography geometry is to be maintained, pixels size of 10 microns or less must be chosen. ESA

N87-24796# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
TRIPLE STEREOSCOPIC IMAGERY SIMULATION AND DIGITAL IMAGE CORRELATION FOR MONOCULAR ELECTRO-OPTICAL STEREO SCANNER (MEOSS) PROJECT c35
Manfred Lehner *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 477-484 Original document contains color illustrations (For primary document see N87-24738 18-43)
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For high precision geometric correction of Monocular Electro-Optical Stereo Scanner imagery digital image correlation software was implemented for automatically finding a sufficiently large number of conjugate points. To test this software triple stereoscopic imagery of CCD scanner type was generated artificially from digital elevation models and image data taken by the Thematic Mapper scanner system. By using all three image pairs a crosscheck of the results of digital image correlation can be done which shows that in the case of the simulated imagery $>$ 90% of the conjugate points of a grid arbitrarily defined in the nadir looking sensor scene can be correctly located. ESA

N87-24797# Tokyo Univ. (Japan). Inst. of Industrial Science.
EARTH RESOURCES SATELLITE (ERS-1) PROJECT IN JAPAN c18
Shunji Murai *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 487-488 (For primary document see N87-24738 18-43)
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The ERS-1 (Japanese spacecraft) sensor system including a synthetic aperture radar, four-band visible/near infrared CCD sensor with stereo mode and a four-band short wave infrared sensor (1.65, 2.10, 2.20 and 2.35 micrometers) is introduced. Applications include monitoring of natural resources as well as agriculture, forestry, fishery, environmental protection, natural disasters, and surveillance of coastal regions. ESA

N87-24798# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Div. of Physics.
SPECTROPHOTOMETRIC MEASUREMENTS ON COLOR AERIAL PHOTOGRAPHS c35
H. Ziemann, J. C. Croteau, J. R. Handy, and E. Nagy *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 491-503 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

It is shown that a microdensitometer can be calibrated to carry out spectrophotometric measurements on aerial photographs. In spite of several approximations necessary to extend the measured PDS 1010M data to the full photometric range and to use available integration tables for the CIE color-matching functions, the results appear to be accurate enough to indicate known characteristics of the used color-emulsions. The used experimental color panels were rather small resulting in relatively noisy PDS 1010M measurements; more accurate results would be obtained with larger panels. The saturation for the used panels is small; higher saturation would be desirable. Results indicate that color panels of the same quality and size as the available neutral density (ND) reflectance panels are desirable for further test photography; color panels provide additional information about the response of color emulsions not available from the ND reflectance panels. ESA

N87-24799# Technische Univ., Vienna (Austria). Inst. fuer Vermessungswesen und Fernerkundung.
PHOTOGRAPHIC QUALITY OF COLOR IR AERIAL PHOTOS AS A FUNCTION OF ATMOSPHERIC PARAMETERS c35
W. Schneider *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 505-509 Sponsored by the Austrian Fonds zup Foerderung der Wissenschaftlichen Forschung (For primary document see N87-24738 18-43)
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The relationship between the contrast of color CIR aerial photos, defined in terms of the image density range (width of density histogram) of a certain land cover type (spruce forest), and the atmospheric conditions during photo acquisition, defined in terms of the total normal optical thickness of the atmosphere as determined by simultaneous terrestrial spectroradiometric measurements, is analyzed. An empirical relationship between these quantities can be used to predict the contrast of aerial photos from terrestrial solar irradiance measurements prior to a planned photo flight. ESA

N87-24800# Jenoptik Jena G.m.b.H. (East Germany).
SOME PROBLEMS OF EXPOSURE METERING IN AERIAL PHOTOGRAPHY c35
Ulrich Zeth and Heinrich Klose *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 511-517 (For primary document see N87-24738 18-43)
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Problems encountered even by well-versed aerial camera operators, resulting from the different definitions of common film speed systems when it comes to calibrating the exposure meter are discussed. Experience gained with the differential exposure metering system of the Jena LMK camera is described, and recommendations for its use at greater flying heights, where the meter readings are more or less influenced by partial integration over the sensed surface are given. ESA

N87-24801# Wageningen Agricultural Univ. (Netherlands).
DETERMINATION OF SPECTRAL REFLECTANCE OF CROPS DURING GROWTH FROM CALIBRATED MULTISPECTRAL SMALL FORMAT AERIAL PHOTOGRAPHY
J. H. Loedeman, J. G. P. W. Clevers, and C. A. Horton (Polytechnic, London, England) *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 519-531 (For primary document see N87-24738 18-43)
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Spectral reflectance factors of crops in field trials were calculated from radiometrically calibrated multispectral aerial photography. The objectives required matching defined spectral bands; film processing under sensitometric control; radiometric correction for effects due to atmosphere and camera; and synthesis of densitometry and photogrammetry. Under meteorological conditions in the Netherlands nearly instant availability of a recording system is needed. Recordings were executed with standard 70 mm cameras, films, and gelatin filters. Densitometry was done using a Macbeth TD-504 modified to a scanning densitometer, interfaced with an HP-85 computer. Results are comparable with those of ground based radiometry. ESA

N87-24802*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PHASE NOISE FROM AIRCRAFT MOTION: COMPENSATION AND EFFECT ON SYNTHETIC APERTURE RADAR IMAGES
Andrew K. Gabriel and Richard M. Goldstein *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors

Nov. 1986 p 535-538 Sponsored by NASA (For primary document see N87-24738 18-43)
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Image degradation of airborne SAR imagery caused by phase errors introduced in the received signal by aircraft motion is discussed. Mechanical motion has a small bandwidth and does not affect the range signal, where the total echo time is typically 60 microsec. However, since the aperture length can be several seconds, the synthesized azimuth signal can have significant errors of which phase noise is the most important. An inertial navigation system can be used to compensate for these errors when processing the images. Calculations to evaluate how much improvement results from compensation are outlined. ESA

N87-24803# Marconi Co. Ltd., Chelmsford (England).
MOTION COMPENSATION AND GEOMETRIC DISTORTION IN AIRBORNE SAR IMAGERY c32
D. Blacknell, I. A. Ward, and A. Freeman *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 539-548 Sponsored by the Royal Signals Research Establishment Procurement Ministry of Defence, United Kingdom (For primary document see N87-24738 18-43)
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The effects of across-track motions and a yawed antenna on the spatial and radiometric performance of an airborne SAR are described. Techniques for Doppler tracking and autofocussing, and the effects of applying these processing procedures to improve radiometric and spatial performance respectively are discussed. The problem of achieving simultaneous spatial and radiometric performance using such techniques was explored. Under the assumption that any defocussing that does occur is due to the path of the SAR platform deviating from a straight line, techniques for achieving simultaneous spatial and radiometric performance are advocated. Processing to the center frequency yielded by the Doppler tracker followed by resampling, to correct the geometry, using the autofocus measurements, appears to be the best approach. ESA

N87-24804# Centre National d'Etudes Spatiales, Toulouse (France).
SPOT IMAGE QUALITY
G. Begni, B. Boissin, and M. Leroy *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 551-556 (For primary document see N87-24738 18-43)
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Postlaunch assessment tests of SPOT image quality are summarized. In goemetric image quality, all specifications are fulfilled, most often with comfortable margins. Length distorsion is 1 order of magnitude better than the specification, due in part to the excellent quality of the satellite attitude control system. The radiometric image quality is also very satisfactory, except for relatively minor problems in signal to noise ratio in the HRV2 panchromatic band. ESA

N87-24805# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Section.
A NEW TEST FACILITY FOR THE DETERMINATION OF THE IMAGE QUALITY OF PHOTOGRAMMETRIC LENSES c74
Hartmut Ziemann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 557-563 (For primary document see N87-24738 18-43)
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A facility for the determination of optical transfer functions from line spread functions measured for aerial lenses was developed. Image quality assessment and results obtained during the testing of the facility are discussed. The determination of set-up parameters to be used for the measurement of line spread functions and results obtained in an effort to check the alignment of critical parts of the facility are described. ESA

N87-24806# Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Photogrammetry.
DETERMINATION OF THE MODULATION TRANSFER FUNCTION FOR AERIAL CAMERAS UNDER FLIGHT CONDITIONS c35
Otto Koebl and Joseph Hawawini *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 565-572 (For primary document see N87-24738 18-43)
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A procedure to determine the modulation transfer function (MTF) under flight conditions is summarized. The measurements were used to compare aerial cameras of different manufacturers. Results show that the usual assumption that the MTF can be considered as a Fourier transformation of a simple Gauss function is misleading. In order to control the obtained MTF, the reproduction of signaled points in aerial photographs is included in the analysis. ESA

N87-24807# Joensuu Univ. (Finland). Dept. of Physics.
RESOLVING POWER PROFILES AND AWAR OF NEW AERIAL CAMERAS c35
J. Hakkarainen *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 573-579 (For primary document see N87-24738 18-43)
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The resolving power (RP) of 14 cameras, 9 film types, and 8 different airplanes was assessed in flight tests. In total 900 aerial photographs were taken. The AWAR values were calculated for every test case. Laboratory results of RP were compared with flight results. ESA

N87-24808# Canada Centre for Remote Sensing, Ottawa (Ontario).
THE USE OF AUXILIARY DATE IN PHOTOGRAMMETRIC ADJUSTMENTS
J. R. Gibson *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 583-588 (For primary document see N87-24738 18-43)
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Inertial Navigation System (INS) data were used in photogrammetric adjustments in an aerial hydrography project, photo inertial positioning project, laser profiler calibration project and stereo line imager project. The INS data provide an estimate of the aircraft position and attitude at specific time samples during a flight line. The INS data is known to be corrupted by long term drifts and offset errors, but provides relatively accurate differential data. The photogrammetric adjustment software models the low frequency error characteristics of the INS. Once the error model coefficients are determined, the derived INS error estimates may be computed and removed from the position and attitude data elements. The corrected INS data is then available for use in processing laser profiler data or for geometrically correcting line imager data. ESA

N87-24809# Institut Geographique National, Paris (France).
USE OF THE TR5-S-B GLOBAL POSITIONING SYSTEM (GPS) RECEIVER IN AIRBORNE PHOTOGRAPHY SURVEYS
R. Brossier, G. Nard, J. Rabian, and R. Gounon *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 589-596 Prepared in cooperation with SERCEL, Nantes (France). (For primary document see N87-24738 18-43)
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The use of Global Positioning System (GPS) signals to improve aerial photography from low dynamics aircraft was assessed in flight tests. Using pseudo range and accumulated phase measurements from these satellites with well calibrated GPS receivers also allows users to reach very low-noise speed and acceleration observations in three dimensions, at a few mm/sec level. The further combination of this technique with phase interferometry onboard a moving platform may also lead to the capability of accurate attitude measurements, to improve

performances in photography surveys, airborne photogrammetry, airborne and shipborne gravimetry, and magnetometry. ESA

N87-24810*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
THE MC AND LFC CAMERAS
Clarice L. Norton, Manfried Schroeder, and Bernard Mollberg *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 601-606 Prepared in cooperation with Air Force Logistics Command, Hill AFB, Utah (For primary document see N87-24738 18-43)
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The characteristics of the shuttle-borne Large Format Camera are listed. The LFC focal plane format was 23 by 46 cm, double the usual size, thereby acquiring approximately double the ground area. Forward motion compensation was employed. With the stable platform (shuttle) it was possible to use the slow exposure, high resolution, Kodak aerial films; 3414 and 3412 black and white, SO-242 color, and SO-131 aerochrome infrared. The camera was designed to maintain stability during varying temperature extremes of space. ESA

N87-24811# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. for Optoelectronics.
EARTH OBSERVATION EXPERIMENTS ON THE GERMAN SPACELAB MISSION D2
F. Lanzl *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 609-616 (For primary document see N87-24738 18-43)
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The Spacelab D2 remote sensing mission applications and equipment are summarized. The Mapping Experiment from Space involves topographic and thematic mapping with an improved Metric Camera. Modular Optoelectronic Multispectral Scanner 2 studies correlation of multispectral and terrain information. The Spacelab Atmospheric Lidar Experiment is designed for determination of atmospheric data for weather forecasts. ESA

N87-24812# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. for Optoelectronics.
THE MONOCULAR ELECTRO-OPTICAL STEREO SCANNER (MEOSS) SATELLITE EXPERIMENT
F. Lanzl *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 617-620 (For primary document see N87-24738 18-43)
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An along track spaceborne threefold scanner flight on the SROSS satellite is introduced. It includes investigation and test of different evaluation methods for threefold stereo scan systems for the planning of future higher resolution systems, and angular dependent reflectance information and frequent coverage of same test area. Applications include meteorology, mapping, environmental monitoring, and geological and forestry surveys. ESA

N87-24813# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. for Optoelectronics.
MODERN CCD SENSORS AND THEIR APPLICATIONS IN EARTH OBSERVATION AND PLANETARY MISSIONS
P. Seige *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 621-625 (For primary document see N87-24738 18-43)
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The characteristics of CCD's are listed. Trends in CCD technology are outlined. ESA

N87-24814# Royal Inst. of Tech., Stockholm (Sweden). Dept. of Photogrammetry.
IMAGE QUALITY PROBLEMS IN PRACTICAL AERIAL PHOTOGRAPHY c35
Anders E. Boberg *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 627-634 (For primary document see N87-24738 18-43)
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Quality problems in land survey aerial photography are reviewed. The geometrical properties of the aerial cameras are checked yearly with the help of aerial photography of ice-covered lakes and stereoscopic height measurements in the images. Manual exposure determination with a correction table and automatic exposure calculation with a built-in integral or spot exposure meter are compared. Results of check measurements of the spectral transmission of color aerial filters are presented and quality problems related to color balance of color infrared film are discussed. Experiences of a subjective image assessment method are reported. ESA

N87-24815# Technische Univ., Munich (West Germany). Faculty of Geosciences.
THE MODULAR OPTOELECTRONIC MULTISPECTRAL SCANNER (MOMS) PROGRAM OF THE BUNDESMINISTERIUM FUER FORSCHUNG UND TECHNOLOGIE (BMFT). MILESTONES IN THE DEVELOPMENT OF AN OPERATIONAL EARTH OBSERVATION SYSTEM c19
J. Bodechtel, D. Meissner, P. Seige, H. Winkenbach (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, West Germany), and J. Zilger *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 635-639 (For primary document see N87-24738 18-43)
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The mission of the Modular Optoelectronic Multispectral Scanner (MOMS) aboard two flights of the Space Transportation System demonstrated the feasibility of the concept with regard to technical and scientific objectives. On account of the successful missions a cooperation was agreed for comparing MOMS observations with operational Landsat-Thematic Mapper data over selected test sites as a means of obtaining relative measure of performance. The results obtained and aspects of MOMS instrument development aiming at the realization of an operational system are presented. ESA

N87-24816*# Ohio State Univ., Columbus. Dept. of Geodetic Science and Surveying.
RADIAL ORBIT ERROR REDUCTION AND SEA SURFACE TOPOGRAPHY DETERMINATION USING SATELLITE ALTIMETRY
Theodossios Engelis Jun. 1987 192 p
(Grant NAG5-519)
(NASA-CR-180570; NAS 1.26:180570; Rept-377) Avail: NTIS HC A09/MF A01 CSCL 08C

A method is presented in satellite altimetry that attempts to simultaneously determine the geoid and sea surface topography with minimum wavelengths of about 500 km and to reduce the radial orbit error caused by geopotential errors. The modeling of the radial orbit error is made using the linearized Lagrangian perturbation theory. Secular and second order effects are also included. After a rather extensive validation of the linearized equations, alternative expressions of the radial orbit error are derived. Numerical estimates for the radial orbit error and geoid undulation error are computed using the differences of two geopotential models as potential coefficient errors, for a SEASAT orbit. To provide statistical estimates of the radial distances and the geoid, a covariance propagation is made based on the full geopotential covariance. Accuracy estimates for the SEASAT orbits are given which agree quite well with already published results. Observation equations are develped using sea surface heights and crossover discrepancies as observables. A minimum variance solution with prior information provides estimates of parameters representing the sea surface topography and corrections to the gravity field that is used for the orbit generation. The simulation results show that the method can be used to effectively reduce the radial orbit error and recover the sea surface topography. Author

N87-24817*# California Univ., Santa Barbara. Information Sciences Research Group.
REMOTE SENSING INFORMATION SCIENCES RESEARCH GROUP: SANTA BARBARA INFORMATION SCIENCES RESEARCH GROUP, YEAR 4 Final Report
John E. Estes, Terence Smith, and Jeffrey L. Star 1 Jun. 1987 17 p
(Grant NAGw-455)
(NASA-CR-181073; NAS 1.26:181073) Avail: NTIS HC A02/MF A01 CSCL 05B

Information Sciences Research Group (ISRG) research continues to focus on improving the type, quantity, and quality of information which can be derived from remotely sensed data. Particular focus in on the needs of the remote sensing research and application science community which will be served by the Earth Observing System (EOS) and Space Station, including associated polar and co-orbiting platforms. The areas of georeferenced information systems, machine assisted information extraction from image data, artificial intelligence and both natural and cultural vegetation analysis and modeling research will be expanded. E.R.

N87-24950# Marconi Avionics Ltd., Rochester (England). Guidance Systems Div.
THE DIGITAL COLOUR MAP SIMPLIFIES GROUND ATTACK OPERATIONS
David W. Hussey *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 8 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N87-24818# Steitz and Associates, Sun Prairie, Wis.
PROCEEDINGS: WORKSHOP ON PROSPECTS AND REQUIREMENTS FOR GEOGRAPHIC EXPANSION OF WIND POWER USAGE
P. Steitz Nov. 1986 64 p Workshop held at Dallas, Tex., 5 Mar. 1986 Prepared in cooperation with Electric Power Research Inst., Palo Alto, Calif.
(Contract DE-AC02-83CH-10093)
(DE87-004104; EPRI-AP-4794; CONF-8603171-Summ) Avail: NTIS HC A04/MF A01

The proceedings of a workshop on the Prospects and Requirements for Geographic Expansion of Wind Power Usage held March 5-6, 1986, in Dallas, Texas are reported. The workshop was sponsored by the Electric Power Research Institute (EPRI) in cooperation with the Solar Energy Research Institute (SERI). SERI is operated by Midwest Research Institute for the US Department of Energy. The workshop participants concluded that there are a number of areas in the United States with substantial wind resources. Determining the potential for development of these resources for wind power will require local, detailed wind measurements. The participants saw no technology barriers to more widespread usage of wind power. They considered the greatest potential for advancement of wind power technology to be in the application of power electronics to enable variable speed wind turbine operation and to integrate and improve wind power station control and protection. Although wind power stations were seen as posing no health hazards, public and utility acceptance of the technology, the participants agreed, will require strong educational activities in all aspects of wind power. The implications of these conclusions for the research programs of EPRI and other sectors are discussed. DOE

N87-24819# Pacific Northwest Labs., Richland, Wash.
WIND ENERGY RESOURCE ATLAS OF THE UNITED STATES
D. L. Elliott, C. G. Holladay, W. R. Barchet, H. P. Foote, and W. F. Sandusky Mar. 1987 212 p
(Contract DE-AC02-83CH-10093)
(DE86-004442; DOE/CH-10093/4) Avail: NTIS HC A10/MF A01

This atlas estimates wind energy resource for the United States and its territories, and indicates general areas where a high wind resource may exist. This information is valuable to wind energy developers and potential wind energy users because it allows them to choose a general area of estimated high wind resource for more detailed examination. DOE

N87-24820# Marconi Space and Defence Systems Ltd., Hillend (Scotland).
GALLIUM ARSENIDE SOLAR ARRAYS FOR APPLICATIONS IN GEOSTATIONARY ORBIT Final Report
D. H. Haywood and J. Howard Paris, France ESA May 1986 104 p
(Contract ESTEC-6247/85-NL-PB)
(BLS-6423; ESA-CR(P)-2299; ETN-87-99863) Copyright Avail: NTIS HC A06/MF A01

A planar trough concentrator (PTC) and Cassegrain concentrator for GaAs solar arrays were compared, showing the feasibility of the PTC. Comparison with straight planar arrays shows that the PTC gives a 10% mass saving, and 40% area reduction, over a GaAs planar as well as a 40% reduction in quantity of cells required, making the GaAs PTC a worthwhile contender for geostationary satellites similar to OLYMPUS. Although the Cassegrain concentrator appears disadvantageous against planar GaAs in terms of mass and area, the saving in cells of 75% and in actual bulk cell material of 98.5% gives the Cassegrain a large cost advantage. The large number of 2 x 2 cm GaAs cells required is considered beyond present supply capability for the planar solution. Therefore the Cassegrain concentrator is considered advantageous for large LEO spacecraft especially if annealing can be perfected. ESA

N87-24821# Florida Univ., Gainesville. Dept. of Materials Science and Engineering.
INVESTIGATION OF SELECTED ELECTRICALLY ACTIVE DEFECTS IN POLYCRYSTALLINE SILICON SOLAR CELL MATERIALS Final Subcontract Report, 30 May 1986
J. Hren Mar. 1987 123 p
(Contract DE-AC02-83CH-10093)
(DE87-001159; SERI/STR-211-3083) Avail: NTIS HC A06/MF A01

Presented is a study on the production of silicon wafers for large-scale, terrestrial, solar energy applications: ESP (edge-supported pulling) silicon sheets and LASS (low angle silicon sheets). Structural properties were analyzed using selected area electron channeling (SAEC); electrical properties were described by means of electron-beam-induced current (EBIC). The transmission electron microscope (TEM) was used to analyze microstructural properties. It was found that the LASS material was semirandomly oriented. In general, the growth direction was parallel to the (211) family of planes. EBIC results of the ESP material showed long, linear bands of poor electrical response. EBIC results of the LASS material showed poor electrical response along grain boundaries and near silicon inclusions and dislocation clusters. TEM results showed a predominance of twins and stacking faults in both the ESP and LASS materials. The poor electrical response may be related to the stacking faults, grain boundaries, and dislocation networks presumably formed by mechanical pulling during sheet formation. Author

N87-24822*# Spectrolab, Inc., Sylmar, Calif.
DESIGN, ANALYSIS AND TEST VERIFICATION OF ADVANCED ENCAPSULATED SYSTEMS Final Report, period ending 31 Oct. 1985
Alexander Garcia, III Nov. 1985 240 p Sponsored in part by DOE Prepared for JPL
(Contract JPL-955567)
(NASA-CR-181084; JPL-9950-1248; DOE/JPL-955567-85/16; NAS 1.26:181084; DRL-126) Avail: NTIS HC A11/MF A01 CSCL 10A

Methods were developed to aid the photovoltaic manufacturer in the design of modules which will optimize the use of materials and method of manufacture for novel encapsulation schemes. Methods are described for using master curves to enable the design of modules which will withstand pressure loading from wind and/or precipitation as well as stress produced from diurnal and seasonal thermal cycling. Analysis methods using finite element modeling are presented to examine maximum electric field concentrations dependent on the geometry of cells and interconnects. Techniques for determining the operating temperature and optical efficiency of panels are presented. Several methods of manufacturing modules are described. Experimental results in the use of conductive polymers in photovoltaic cells as AR coatings, conductivity enhancers, and passivation coatings are discussed. Author

N87-24823*# Stanford Univ., Calif. Dept. of Materials Science and Engineering.
STUDIES OF THE NATURE OF INTERFACIAL BARRIERS IN HIGH EFFICIENCY CRYSTALLINE SILICON SOLAR CELLS Final Report, 5 Oct. 1984 - 4 Oct. 1985
Clayton W. Bates, Jr. 1985 9 p Sponsored in part by DOE Prepared for JPL
(Contract JPL-956960)
(NASA-CR-181085; JPL-9950-1257; DOE/JPL-956960-1; NAS 1.26:181085; DRL-217) Avail: NTIS HC A02/MF A01 CSCL 10A

The effects of interfacial barriers in crystalline silicon solar cells were studied. The effort was directed toward the investigation and use of such techniques as Angular Resolved Parameter Spectroscopy (ARAPS) and Impedance Spectroscopy in initially characterizing n-type Si doped to levels commonly used for n+p solar cells, and eventually Si solar cells. The objectives of the research are given. Those accomplished are detailed, as are recommendations for future work. E.R.

N87-24824*# Florida Univ., Gainesville. Dept. of Electrical Engineering.
HEAVY DOPING EFFECTS IN HIGH EFFICIENCY SILICON SOLAR CELLS Quarterly Report, 1 Jan. - 31 Mar. 1986
F. A. Lindholm and A. Neugroschel 1986 35 p Sponsored in part by DOE Prepared for JPL
(Contract JPL-956525)
(NASA-CR-181080; JPL-9950-1226; DOE/JPL-956525-86/1; NAS 1.26:181080; DRL-198; DRD-SE-11) Avail: NTIS HC A03/MF A01 CSCL 10A

The temperature dependence of the emitter saturation current for bipolar devices was studied by varying the surface recombination velocity at the emitter surface. From this dependence, the value was derived for bandgap narrowing that is in better agreement with other determinations that were obtained from the temperature dependence measure on devices with ohmic contacts. Results of the first direct measurement of the minority-carrier transit time in a transparent heavily doped emitter layer were reported. The value was obtained by a high-frequency conductance method recently developed and used for doped Si. Experimental evidence is presented for significantly greater charge storage in highly excited silicon near room temperature than conventional theory would predict. These data are compared with various data for delta E sub G in heavily doped silicon. Author

N87-24825# International Centre for Theoretical Physics, Trieste (Italy).
SOLAR CELL CONCENTRATING SYSTEM
H. P. Garg, V. K. Sharma, and R. K. Agarwal Nov. 1986 50 p (DE87-701762; IC-85/313) Avail: NTIS (US Sales Only) HC A03/MF A01

This study reviews fabrication techniques and testing facilities for different solar cells under concentration which have been developed and tested. It is also aimed to examine solar energy concentrators which are prospective candidates for photovoltaic concentrator systems. This may provide an impetus to the scientists working in the area of solar cell technology. DOE

N87-24826# Kernforschungszentrum, Karlsruhe (West Germany). Inst. Fuer Neutronenphysik und Reaktortechnik.
BUFFER STORAGE OF THERMAL ENERGY USING THE REACTION HEAT OF THE SYSTEM CALCIUM OXIDE/CALCIUM HYDROXIDE Thesis - Karlsruhe Univ., West Germany
B. Lehmann Dec. 1986 134 p In GERMAN; ENGLISH summary
(KfK-4155; ISSN-0303-4003; ETN-87-99653) Copyright Avail: NTIS HC A07/MF A01

The reaction heat of the system CaO/Ca(OH)2 was investigated as storage effect for thermal energy. The heat from the chemical system is used as a buffer facility for thermal energy, i.e., sensible heat is stored without thermal losses to the environment. In the forward reaction by adding water to the CaO, sensible heat is released, which can be used for heating houses or water, and for generation of steam for industrial purposes. The necessary heat to be fed to the Ca(OH)2 in order to run the reaction inversely can be supplied by solar collector, high temperature reactors, geothermal energy, or combustion of wastes. Heat at temperatures less than 450 C has to be furnished for the loading phase of the reaction. The discharging reaction delivers temperatures up to 400 C. A gas loop was designed, built, and operated to test this kind of heat storage. The quantities which determine the storage and release of energy were deduced and documented. Pressure drops and storage mass behavior are discussed. ESA

N87-24827# NUKEM G.m.b.H., Hanau (West Germany). Zentralabteilung Forschung und Entwicklung.
HYDROGEN POLLUTION BY SOLAR-INDUCED REDOX REACTIONS IN MICROHETEROGENEOUS SIGNALS Final Report, Dec. 1984
Winfried Hoffmann Bonn, West Germany BMFT Sep. 1986 92 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-074; ISSN-0340-7608; ETN-87-99691) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 19

Results from bench-scale experiments aiming at the photochemical splitting of water into hydrogen and oxygen were examined from the viewpoint of technical realization and availability. Specific catalyst carriers on the basis of titanium dioxide (anatase, rutile, and amorphous structures) were produced in a reproducible way. Catalysts were deposited using different methods, and were characterized by atomic absorption, X-ray fluorescence, electron microscopy, and photoelectron spectroscopy. Ordinary and functionalized sensitizers were tested. The photocatalytic activity for water reduction and water oxidation was determined in various systems, emphasizing the oxidation step. Water splitting into hydrogen and oxygen is confirmed. Microheterogeneous systems for solar hydrogen production seem to be competitive compared to photovoltaically driven water electrolysis systems. ESA

N87-24828# Battelle Inst., Frankfurt am Main (West Germany).
DEVELOPMENT OF A CdSe THIN FILM SOLAR CELL Final Report, Aug. 1983
Hilmar Richter and Edmund Rickus Bonn, West Germany BMFT Dec. 1986 100 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-091; ISSN-0340-7608; ETN-87-99696) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 21

Investigations and optimizations of CdSe MIS thin-film solar cells are reviewed. A photovoltaic AM1 efficiency of over 7% at 0.6 sqcm active area was obtained. Short-circuit current density of 20mA/sqcm achieved with CdSe 0.95 Te 0.05 cells corresponds to 80% of the theoretical maximum value. The I-layer which affects mainly the open-circuit voltage and the filling factor of the cell, consists of ZnSe. Low level Cu doping of this layer significantly enhances the filling factor. Irradiation with UV light increases the open-circuit voltage and (slightly) the filling factor, to values of 0.6V and up to 60%, respectively. Investigations of electrochemical solar cells based on polycrystalline CdSe films and CdSe single crystals led to open-circuit voltages of 1V, and indicate the development potential of the CdSe cell. The excellent stability and simple production techniques of the CdSe thin-film cell, combined with materials consumption, give rise to the expectation of low cost solar cells of an efficiency above 10%. ESA

N87-24829# Poly Solar, Inc., Garland, Tex.
FEASIBILITY OF USING COPPER INDIUM DISULFIDE FOR HIGH-EFFICIENCY, THIN-FILM SOLAR CELLS Final Subcontract Report, 1 Feb. 1985 - 30 Sep. 1986
Apr. 1987 34 p Prepared for Midwest Research Inst., Goldon, Colo.
(Contract DE-AC02-88CH-10093)
(DE87-001168; SERI/STR-211-3127) Avail: NTIS HC A03/MF A01

The deposition of CuInS2 films was investigated to determine the feasibility of using CuInS2 for high efficiency, thin film solar cells. Two techniques were investigated for depositing p-CuInS2 films on foreign substrates: (1) the close spaced chemical vapor transport (CSCVT) technique, and (2) the deposition of Cu-In films by the thermal reduction of Cu and In compounds or by electro-deposition, followed by sulfurization. The photoresponse of CSCVT CuInS2 films was poor, possibly due to stoichiometry, defects, or impurities. The deposition of Cu-In alloy films on W/Al2O3 and Mo/glass substrates was carried out by thermal reduction of a mixture of Cu(NO3)2 and In(NO3)2. However, relatively high temperatures were required, due to stability of In2O3. The photovoltaic characteristics of CuInS2 films prepared from electroplated Cu-In were similar to those from CSCVT; the highest open circuit voltage and short circuit current density were 0.35 V and 3 mA/Cm2. The photoresponses of CuInS2 films from chemically deposited Cu-In alloy are considerably inferior.
Author

N87-24830# Battelle Columbus Labs., Ohio.
GAS ENGINE HEAT PUMP SYSTEM AND COMPONENT EFFICIENCY AND RELIABILITY IMPROVEMENT, PHASE 1 Report, Jun. 1985 - Jan. 1987
Jan. 1987 113 p
(Contract GRI-5084-242-1118)
(PB87-176335; N-4577-0901; GRI-87/0006) Avail: NTIS HC A06/MF A01 CSCL 10B

The Gas Research Institute is directing several research projects to develop gas fired heat pumps for residential and light commercial use. The project work discussed in the report identifies and evaluates potential improvements in the cycle and key components of these heat pumps and provides short- and long-term inputs for the heat pump product development efforts. Principal results of Phase I studies under the project are: test procedures for gas fired heat pumps (GFHP), a cycle analysis model for GFHP's, an assessment of appropriate compressor technology for GFHP's, specification of fan operating strategies, a review of emission standards for GFHP's, identification of low-temperature capacity enhancement issues, a guide on the sizing of field tests, current assessments of foreign technology valuable to GFHP's, and an assessment of the health and safety attributes of methylene chloride. GRA

N87-24831# IIT Research Inst., Chicago, Ill.
CORROSION OF MATERIALS IN MOLTEN CARBONATE FUEL CELLS (MCFC): LITERATURE REVIEW
29 Jan. 1987 109 p
(Contract DE-AC21-86MC-23265)
(DE87-001085; DOE/MC-23265/2304; IITRI-P06064-4) Avail: NTIS HC A06/MF A01

Molten carbonate fuel cell (MCFC) separator plates are subjected to corrosive environments. This review focuses on the most comprehensive compiled available data from the major government contractors like ERC and UTC, together with a basic review of alloys resistant to oxidation, sulfidation, carburization, and hot corrosion. Results of this review are used in selecting test materials for the current program. A number of metal oxides were examined. This review discusses the tests performed by UTC and ERC on separator plate materials. DOE

N87-24832# Sandia National Labs., Albuquerque, N. Mex.
PHOTOVOLTAIC/DIESEL HYBRID SYSTEMS: THE DESIGN PROCESS
G. J. Jones and R. N. Chapman 1987 8 p Presented at the 19th IEEE Photovoltaic Specialists Conference, New Orleans, La., 4 May 1987
(Contract DE-AC04-76DP-00789)
(DE87-009052; SAND-87-1203C; CONF-870528-7) Avail: NTIS HC A02/MF A01

A photovoltaic/storage system by itself may be uneconomical for stand-alone applications with large energy demands. However, by combining the PV system with a back-up energy source, such as a diesel, gasoline, or propane/thermoelectric generator, system economics can be improved. Such PV/fossil hybrid systems are being used, but their design has required detailed modeling to determine the optimal mix of photovoltaics and back-up energy. Recent data on diesel field reliability and a new design technique for stand-alone systems have overcome this problem. The approach provides the means for sizing the photovoltaic system to obtain a near optimal hybrid system, with about a 90% savings in back-up fuel costs. System economics are determined by comparing PV capital cost to the present value of the displaced diesel operation and maintenance costs. DOE

N87-24833# Sandia National Labs., Albuquerque, N. Mex.
RELIABILITY RESEARCH AND CELL ASSEMBLY DESIGN FOR PHOTOVOLTAIC CONCENTRATOR MODULES
C. J. Chiang and E. H. Richards 1987 18 p Presented at the 19th IEEE Photovoltaic Specialists Conference, New Orleans, La., 4 May 1987
(Contract DE-AC04-76DP-00789)
(DE87-009055; SAND-87-1179C; CONF-870528-10) Avail: NTIS HC A02/MF A01

Sandia National Laboratories is pursuing research on the reliability of photovoltaic concentrator cell assemblies. Active research topics include selection of solders and soldering processes, modeling of solder fatigue, investigation of metallization adhesion, evaluation of adhesives and coatings, and analysis of hot-spot heating and the effects of module shading. Hardware and material samples are subjected to test environments including temperature and humidity cycling, and ultraviolet and outdoor exposure. Evaluation techniques used to detect flaws or degradation are electrical performance measurements, ultrasonic imaging, radiography, optical transmission and reflection measurements, pull tests, and current leakage measurements. Analysis tools are failure modeling, holographic deformation visualization, and finite element stress calculation. The procedures and results of our reliability research concerning cell assemblies are described. We present our ideas for the design of cell assemblies for high efficiency, low cost, and enhanced reliability.
DOE

N87-24834# Sandia National Labs., Albuquerque, N. Mex. Photovoltaic Cell Research Div.
VOLTAGE-MATCHED CONFIGURATIONS FOR MULTIJUNCTION SOLAR CELLS
James M. Gee 1987 7 p Presented at the 19th IEEE Photovoltaic Specialists Conference, New Orleans, La., 4 May 1987
(Contract DE-AC04-76DP-00789)

(DE87-009056; SAND-87-1210C; CONF-870528-9) Avail: NTIS HC A02/MF A01

Novel methods for interconnecting the subcells of a multijunction solar cell are investigated. The subcells are connected in parallel in these new methods. The bandgaps of the subcells must be selected for matched voltages when operated in parallel. We refer to multijunction solar cells with the subcells connected in parallel as having a voltage-matched configuration. Computer analyses of multijunction solar cells with a voltage-matched configuration and with series-connected subcells were performed. Roughly, the same performance with either approach for a multijunction cell with optimized bandgaps was found. Several advantages for the voltage-matched configuration relative to multijunction solar cells with series-connected subcells were identified, including wider selection of bandgaps for optimal performance, less sensitivity to radiation damage, and less sensitivity to spectral variations. DOE

N87-24835# Sandia National Labs., Albuquerque, N. Mex. Photovoltaic Cell Research Div.

CHARACTERIZATION OF THE Isc VERSUS IRRADIANCE RELATIONSHIP FOR SILICON AND III-V CONCENTRATOR CELLS

James M. Gee 1987 22 p Presented at the 19th IEEE Photovoltaic Specialists Conference, New Orleans, La., 4 May 1987

(Contract DE-AC04-76DP-00789)

(DE87-009057; SAND-87-1209C; CONF-870528-12) Avail: NTIS HC A02/MF A01

The responsivity (which is defined as the short-circuit current divided by the irradiance) of silicon and III-V concentrator cells was measured for irradiances up to 1000X. The silicon cells have various resistivities and thicknesses and have both planar and non-planar junction geometries. We have investigated high-resistivity silicon cells since future advanced silicon concentrator cells will probably use high-resistivity material. Substantial sublinearities of Isc versus irradiance were found in all the high-resistivity silicon cells that we evaluated. In contrast, the III-V concentrator cells (InGaAs and GaAs) were both found to be linear up to 1000X. DOE

N87-24836# Sandia National Labs., Albuquerque, N. Mex.

OPTICAL ENERGY TRANSFER SUBASSEMBLIES

B. A. Tuttle, B. H. Rose, R. G. Keefe, and D. J. Brunty Apr. 1987 56 p

(Contract DE-AC04-76DP-00789)

(DE87-009235; SAND-87-0163) Avail: NTIS HC A04/MF A01

Transfer of energy into an electrically isolated region by optical energy transfer subassemblies (OETS) was investigated. The OETS were based on photovoltaic conversion of light from a directly modulated semiconductor laser coupled by an optical fiber to a single junction solar cell. A ferrite core transformer increased the voltage to desired levels inside the isolated region. Two specific functions were characterized: (1) energizing a half-wave rectifier circuit for a continuous 5 V power source and (2) charging a capacitor. Our best subassembly supplied 5.5 V and 0.5 mA continuously and charged a 30 f capacitor to 27 V in 3 s. DOE

N87-24837# Owens-Illinois, Inc., Toledo, Ohio.

LUMINESCENT SOLAR CONCENTRATOR DEVELOPMENT Final Subcontract Report, 1 Jun. 1982 - 31 Dec. 1984

P. S. Friedman and C. R. Parent Apr. 1987 204 p Prepared for Midwest Research Inst., Golden, Colo.

(Contract DE-AC02-83CH-10093)

(DE87-001172; SERI/STR-211-3149) Avail: NTIS HC A10/MF A01

Experimental and theoretical results of an investigation of luminescent solar concentrators (LSCs) are summarized. An assessment of the LSC technology was compiled to provide a concise description to guide future research in this field. Since 1978, tremendous progress was made in the development of this device as a practical nonimaging concentrator for achieving solar concentration ratios on the order of 10X. The two most important technical achievements appear to be first, the understanding that dye self-absorption of radiated energy is not as serious a problem as originally thought; and second, the demonstration that organic dyes in polymeric hosts are capable of surviving outdoors in bright sunlight for years without serious degradation. System efficiencies approaching 4% were achieved for photovoltaic conversion and theoretical efficiencies on the order of 9% appear feasible for large-area devices. Author

N87-24838*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF COMPONENT COMPRESSION ON THE INITIAL PERFORMANCE OF AN IPV NICKEL-HYDROGEN CELL

Randall F. Gahn 1987 17 p Prepared for presentation at the 22nd Intersociety Energy Conversion Engineering Conference, Philadelphia, Pa., 10-14 Aug. 1987; cosponsored by AIAA, ANS, ASME, SAE, IEEE, ACS, and AIChE

(NASA-TM-100102; E-3590; NAS 1.15:100102; AIAA-87-9257) Avail: NTIS HC A02/MF A01 CSCL 10C

An experimental method was developed for evaluating the effect of component compression on the charge and discharge voltage characteristics of a 3 1/2 in. diameter boiler plate cell. A standard boiler plate pressure vessel was modified by the addition of a mechanical feedthrough on the bottom of the vessel which permitted different compressions to be applied to the components without disturbing the integrity of the stack. Compression loadings from 0.94 to 27.4 psi were applied by suspending weights from the feedthrough rod. Cell voltages were measured for 0.96-C, 55-min charge and for 1.37-C, 35-min and 2-C, 24-min discharges. An initial change in voltage performance on both charge and discharge as the loading increased was attributed to seating of the components. Subsequent variation of the compression from 2.97 to 27.4 psi caused only minor changes in either the charge or the discharge voltages. Several one month open-circuit voltage stands and 1100 cycles under LEO conditions at the maximum loading have produced no change in performance. Author

45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N87-24839# Naval Ocean Systems Center, San Diego, Calif.

AIRBORNE LIDAR AEROSOL MEASUREMENTS Final Report, Jun. - Oct. 1986

M. R. Paulson and D. R. Jensen Jan. 1987 83 p

(AD-A178331; NOSC/TD-1047) Avail: NTIS HC A05/MF A01 CSCL 04A

A least-square-fit technique was used to fit lidar range-corrected power returned, S(R), data to a straight line for lidar shots made from an aircraft. These fits were made for data over a range of 0.12 to 1.0 km, regardless of the goodness-of-fit. The large difference between the lidar results and the Knollenberg data needs to be explained. While the slope method does not appear to be a good way to obtain accurate backscatter and extinction data, differences between the lidar and Knollenberg data of the magnitude observed cannot be explained on this basis. Additional lidar-data-gathering flights would be useful to further test the results observed here. In particular, a wider range of the relative humidity values would be of interest. Also, longer horizontal runs and more accurate determinations of the time of the lidar shots should be made. GRA

N87-24840# National Oceanic and Atmospheric Administration, Washington, D. C. Assessment and Information Services Center.

MARINE ENVIRONMENTAL ASSESSMENT: GULF OF MEXICO, 1985 Annual Summary

K. B. Pechmann, J. O. Ellis, F. G. Everdale, S. Z. Green, and I. C. Sheifer Dec. 1986 122 p

(PB87-160057) Avail: NTIS HC A06/MF A01 CSCL 04A

The Gulf of Mexico 1985 Annual Assessment presents a synoptic view of several economic sectors and their direct and

indirect relations to the physical and biological aspects of the marine and atmospheric environments. The report is comprised of seven sections. In the introductory section the authors define the concept of an assessment as embodied in the report, specify the coverage of the present report, and suggest areas of extension and future development. In section 2 the authors present a summary of impacts they have identified for 1985. Sections 3 through 6 contain details of the weather and ocean conditions, fisheries, recreation, and transportation in the Gulf Of Mexico marine environment for 1985. Section 7 contains a discussion of a selected environmental issue in the Gulf, the disposition of abandoned offshore oil and gas platforms. GRA

N87-24841# Environmental Protection Agency, Research Triangle Park, N.C. Atmospheric Sciences Research Lab.
MODELING NON-PRECIPITATING CUMULUS CLOUDS AS FLOW-THROUGH-REACTOR TRANSFORMER AND VENTING TRANSPORTER OF MIXED LAYER POLLUTANTS
J. K. S. Ching Mar. 1987 14 p
(PB87-167102; EPA/600/D-87/074) Avail: NTIS HC A02/MF A01 CSCL 13B

A simple diagnostic model of cumulus convective clouds is developed and used in a sensitivity study to examine the extent to which the rate of change of mixed and cloud layer pollutant concentration is influenced by vertical transport and chemical transformation processes occurring as a result of cumulus clouds. The aqueous phase chemical transformation process is parameterized and modeled as a flow through batch reactor. The net vertical exchange between the mixed and cloud layers by cumulus cloud elements that protrude above the dry convective mixed layer is modeled as the product of a venting velocity and the difference in pollutant concentration between the mixed and cloud layer. The two layer model yields an analytic expression involving key parameters such as areal extent of cloud cover, dry deposition rates, thickness in mixed and cloud layers, and the initial concentration difference between the mixed and cloud layers. The model solution was programmed using LOTUS 123. GRA

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; inospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

N87-24842# Air Force Geophysics Lab., Hanscom AFB, Mass.
MIDDLE ATMOSPHERE DENSITY AND MODELS
K. S. Champion 9 Apr. 1987 9 p
(AD-A179059; AFGL-TR-87-0116) Avail: NTIS HC A02/MF A01 CSCL 04A

The 80 to 130 km altitude region is our old ignorosphere, the region of the atmosphere that no one seems to be interested in, and yet the critical region for shuttle entry and atmospheric braking. Comparison between the Air Force reference atmosphere and Shuttle IMU data shows large fluctuations at high latitudes. New data sources are available now, such as the Arecibo and Millstone Hill ionospheric scatter radars. Author (GRA)

N87-24843 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensbereich Apparate.
LABORATORY EXPERIMENT FOR TESTING THE GRAVIMAGNETIC HYPOTHESIS WITH SQUID DETECTORS
A. Harasim, I. vonLudwiger, W. Kroy, and H. Th. Auerbach 1985 9 p Presented at SQUID-Tagung, Berlin, West Germany, 25-28 Jun. 1985
(MBB-UA-897/85; ETN-87-99339) Avail: NTIS HC A02

It is suggested that in addition to the Barnett effect, there is another magnetization process in nature which is proportional to the total mass of the rotating body, or, more precisely, to its total angular momentum. Since the magnetic field has a maximum on the axis, an experiment to measure the field in the center of the rotating body is proposed. The body itself should not exhibit the Barnett effect, so materials with nonsaturated spin moments must be avoided. The effect to be measured being very weak, the whole assembly should be installed in a magnetically shielded chamber. ESA

N87-24844*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PHOTON COUNTS FROM STELLAR OCCULTATION SOURCES
James J. Buglia Jul. 1987 16 p
(NASA-TM-89085; L-16235; NAS 1.15:89085) Avail: NTIS HC A02/MF A01 CSCL 03A

The feasibility of using stars as radiation sources for Earth atmospheric occultation experiments is investigated. Exoatmospheric photon counts of the order of 10 to the 6th power photons/sq cm/sec are realized for the 15 visually brightest stars. Most photon counts appear to be marginally detectable unless photomultiplier or cascade detection devices can be used. Author

N87-24845# International Centre for Theoretical Physics, Trieste (Italy).
PREDICTING DIFFUSE RADIATION WHERE ONLY DATA ON SUNSHINE DURATION IS AVAILABLE
J. G.M. Massaquoi Dec. 1985 19 p
(DE87-701754; IC-85/212) Avail: NTIS (US Sales Only) HC A02/MF A01

In most locations there are no data on either global or diffuse radiation. Yet most of the existing correlations for predicting the latter require measured data on the former. This is because these correlations express the diffuse radiation as a function of the clearness index. To overcome this, one approach has been to develope correlations of diffuse radiation as a function of sunshine hours. This paper considers another approach: that of using predicted values of global radiation when measured values are not available. With this approach one could then use correlations of diffuse radiation as a function of clearness index. We have carried out a comparative assessment of the two approaches and reached the conclusion that the latter is more accurate. DOE

N87-24846# International Centre for Theoretical Physics, Trieste (Italy).
ACCURATE COMPUTATIONS OF MONTHLY AVERAGE DAILY EXTRATERRESTRIAL IRRADIATION AND THE MAXIMUM POSSIBLE SUNSHINE DURATION
P. C. Jain Dec. 1985 20 p
(DE87-701757; IC-85/263) Avail: NTIS (US Sales Only) HC A02/MF A01

The monthly average daily values of the extraterrestrial irradiation on a horizontal plane and the maximum possible sunshine duration are two important parameters frequently needed in various solar energy applications. Using the accurate analytical expressions developed by Spencer for the declination and the eccentricity correction factor, computations for these parameters have been made for all the latitude values from 90 deg N to 90 deg S at intervals of 1 deg and are presented in tabular form. Monthly average daily values of the maximum possible sunshine duration as recorded on a Campbell Stoke sunshine recorder are also computed and presented. DOE

N87-24847# International Centre for Theoretical Physics, Trieste (Italy).
COMPARISON OF THE ANGSTROM-TYPE CORRELATIONS AND THE ESTIMATION OF MONTHLY AVERAGE DAILY GLOBAL IRRADIATION
S. Jain and P. C. Jain Dec. 1985 20 p
(DE87-701758; IC-85/264) Avail: NTIS (US Sales Only) HC A02/MF A01

Linear regression analysis of the monthly average daily global irradiation and the sunshine duration data of eight Zambian locations has been performed using the least square technique. Good correlation (r greater than 0.95) is obtained in all cases showing that the angstrom equation is valid for the Zambian locations. The values of the correlation parameters thus obtained

show substantial unsystematic scatter. The analysis was repeated after incorporating the effects of (1) multiple reflections of radiation between the ground and the atmosphere, and (2) not burning the sunshine recorder chart, into the Angstrom equation. The surface albedo measurements at Lusaka were used. The scatter in the correlation parameters was investigated by graphic representation, by regression analysis of the data of the individual stations as well as the combined data of the eight stations. The results show that the incorporation of none of the two effects reduces the scatter significantly. DOE

N87-24848# International Centre for Theoretical Physics, Trieste (Italy).
IMPROVED CORRELATION OF MONTHLY MEAN DAILY AND HOURLY DIFFUSE RADIATION WITH THE CORRESPONDING GLOBAL RADIATION FOR INDIAN STATIONS
H. P. Garg and S. N. Garg Dec. 1985 29 p
(DE87-701759; IC-85/265) Avail: NTIS (US Sales Only) HC A03/MF A01

Several existing correlations between radiation monthly mean ratios of global to extraterrestrial and diffuse to global were tried for four Indian stations and found inadequate. New correlations were established for these stations and it was shown that these correlations are highly climate dependent. The classical equation of Liu and Jordon was tried to find hourly diffuse and global radiation from daily sums of diffuse and global radiation respectively. It was suitably modified to suit the Indian data. Equations developed by Collares-Pereira and Rabl have shown excellent agreement with the observed values. DOE

N87-24849# International Centre for Theoretical Physics, Trieste (Italy).
STATISTICAL ANALYSIS OF SOLAR RADIATION ON VARIOUSLY ORIENTED SLOPING SURFACES
H. P. Garg and S. N. Garg Dec. 1985 32 p
(DE87-701761; IC-85/312) Avail: NTIS (US Sales Only) HC A03/MF A01

For four years, daily global radiation on a south facing surface and on four vertical walls has been computed and statistically analyzed for each of the following stations: New Delhi, Calcutta, Poona and Madras. Daily direct radiation at normal incidence at New Delhi has also been studied. It has been found that maximum global radiation is 30 MJ/m/day for a south facing tilted surface, 21 MJ/m/day for a south wall, 18 MJ/m/day for an east west wall, and 12 MJ/m/day for a north wall. Maximum direct radiation at normal incidence at New Delhi is also 30 MJ/m/day. For a south facing tilted surface, nearly 80% of the days have energy between 21 and 27 MJ/m/day. Atmospheric transmittance for direct radiation is seen to vary from 20% in July to 52% in November. DOE

N87-24850 Alaska Univ., Fairbanks.
NUMERICAL STUDY OF THE ATMOSPHERIC RADIATIVE TRANSFER PROCESS WITH APPLICATION TO THE ARCTIC ENERGY BALANCE Ph.D. Thesis
Si-Chee Tsay 1986 266 p
Avail: Univ. Microfilms Order No. DA8704877

A high-order discrete-ordinate approximation is utilized to solve the radiative transfer equation for both solar and terrestrial spectra. The solutions were compared with other methods and found to be reliable and efficient. These solutions were used to construct a complete and comprehensive radiation model for the arctic atmosphere. The radiation model treats Rayleigh scattering, gaseous absorption/emission, scattering and absorption/emission by cloud droplets and haze particles. Snow conditions of the arctic region are simulated by snow grains and soot contamination in the surface layers. A unified treatment of shortwave and longwave radiative transfer is achieved. Use was made of the five McClatchey atmospheres and of data from the Arctic Stratus Cloud Experiment collected in 1980. Results are compared among broad-band, narrow-band and line-by-line computations. Dissert. Abstr.

N87-24851 Colorado State Univ., Fort Collins.
THE DYNAMICS OF THERMALS AND THEIR CONTRIBUTION TO MIXED LAYER PROCESSES Ph.D. Thesis
George Spencer Young 1986 301 p
Avail: Univ. Microfilms Order No. DA8705494

The dynamics of thermal updrafts and compensating environmental downdrafts in the Convective Boundary Layer are examined using the observations from the Phoenix 78 field experiment. A conditional sampling technique based upon the universal mixed layer spectra of vertical velocity was developed and used to distinguish thermals from the environment. The spectra show that the buoyant production of vertical velocity variance occurs primarily at horizontal scales of from 0.1 to 10.0 times the depth of the boundary layer. A diagnostic model was developed which permits the determination, from observations, of the lateral mass exchange between thermal updrafts and the environmental downdrafts and the pressure forces acting on the vertical velocity in these two regions. The time tendency terms in the budget are small while the effects of lateral mixing and pressure are large. Dissert. Abstr.

N87-24852# Utah State Univ., Logan. Center for Space Engineering.
INSTRUMENTATION FOR INFRARED AIRGLOW CLUTTER Final Report, Jul. 1984 - May 1986
James C. Ulwick 10 Mar. 1987 31 p
(Grant AF-AFOSR-0192-84)
(AD-A179712; CSE/87-012; AFOSR-87-0370TR) Avail: NTIS HC A03/MF A01 CSCL 04A

Two measurements systems have been completed to provide the capability to make high resolution spatial and temporal measurements of infrared structures of the aurora & airglow. The two systems are: 1) GAZER (Graphics Aided Zonal Energy Recorder) - a low light level, wide angle TV imaging and recording system with the capability of storing information regarding absolute intensity levels of the image for subsequent recall and analysis; and 2) Scanning IR Radiometer - a microprocessor controlled tracking mount which drives an IR radiometer through programmable repeatable scan patterns to provide sky maps of the temporal and space small and large scale inhomogeneities. GRA

N87-24853*# Texas Univ., Dallas. Center for Space Sciences.
ION MASS SPECTROMETER EXPERIMENT FOR ISIS-2 SPACECRAFT Final Report
John H. Hoffman 22 Jul. 1987 13 p
(Grant NsG-5087)
(NASA-CR-180990; NAS 1.26:180990) Avail: NTIS HC A02/MF A01 CSCL 04A

The International Satellite for Ionospheric Studies (ISIS) program of NASA was the longest duration program in NASA history. A number of satellites were flown under this program, the last being called ISIS-2, which was launched on April 1, 1971 and operated successfully for over 13 years. An experiment called the Ion Mass Spectrometer (IMS) was flown on the ISIS-2 spacecraft. It operated for 10 years providing a large data base of positive ion composition and ion flow velocities along the orbit of the satellite, the latter being circular at 1400 km with a 90 degree inclination. The data were processed and reside in the National Space Sciences Data Center. Author

N87-24854# National Center for Atmospheric Research, Boulder, Colo.
STEADY STATE PLANETARY WAVE RESPONSE TO WAVE-COUPLED OROGRAPHIC LOWER BOUNDARY FORCING AND DIABATIC HEATING IN THE NORTHERN HEMISPHERE
S. C. Chen 1986 174 p Prepared in cooperation with Illinois Univ.,Urbana
(Grant NSF ATM-82-17015)
(PB87-163556; NCAR/CT-103) Avail: NTIS HC A08/MF A01 CSCL 04A

A planetary wave model which is symmetric about the equator has been developed using the linear balance set of equations.

The model is formulated on a sphere with spherical geometry and spectrally truncated to 4 zonal and 7 meridional modes. There are eleven levels in the vertical with the highest computational level at 5 mb. The model is linearized about a realistic observed January zonal mean basic state and forced by the Northern Hemisphere orography and a wintertime calculated diabatic heating. A wave-coupled LBC (lower boundary condition) is employed in the planetary wave model and contrasted to the wave-decoupled LBC which has been used in many other forced planetary wave models. Thus the eddies at the lower boundary also flow over the mountains and produce vertical motion. In this way, although the model remains linear, planetary waves are coupled through the LBC and the model equations have to be solved simultaneously. GRA

N87-24855# National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Lab.
LIDAR OBSERVATIONS OF STRATOSPHERIC AEROSOL OVER MAUNA LOA OBSERVATORY: 1984-1985
J. DeLuisi, T. DeFoor, and D. Longenecker Sep. 1986 71 p
(PB87-157525; NOAA-DR-ERL-ARL-9) Avail: NTIS HC A04/MF A01 CSCL 13B

Eighty-five lidar profiles obtained during the years 1984-1985 are presented. Backscattering ratios are displayed in graphical form for 1-km intervals. Aerosol backscatter cross section, Rayleigh backscatter cross section, backscatter ratios, and integrated optical thickness, all for 1-km intervals per kilometer are displayed in tabular form. This is the third Mauna Loa lidar data report to be issued. It contains figures and tables for 85 individual stratospheric aerosol lidar soundings. The stratospheric aerosol remaining from the eruption of el Chichon (17 degs N, 16 degs W) March 28 and April 4, 1982, is still seen in the lidar data. The contribution from this eruption was comparatively small even though the eruption itself was quite violent. GRA

N87-24856*# National Aeronautics and Space Administration, Washington, D.C.
THE PARADOX OF AGE: TECTITES AND TECTITE SHOWERS
E. P. Izokh Jun. 1987 18 p Transl. into ENGLISH from Meteoritika (Moscow, USSR), no. 44, 1985 p 127-134 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20102; NAS 1.77:20102) Avail: NTIS HC A02/MF A01 CSCL 08G

When discussing the problem of tectite origin, the age of the tectites themselves (actual glasses) must be distinguished from the date of their fall on the earth's surface, i.e., the geological age of tectite fields. The considerable difference between their two ages is the essence of the paradox which will be discussed here. Author

N87-24857*# National Aeronautics and Space Administration, Washington, D.C.
TECTITES OF VIETNAM. TECTITES DELIVERED BY A COMET: A HYPOTHESIS
E. P. Izokh and Le Dyk An Jun. 1987 26 p Transl. into ENGLISH from Meteoritica (Moscow, USSR), no. 42, 1983 p 158-170 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASw-4004)
(NASA-TT-20103; NAS 1.77:20103) Avail: NTIS HC A03/MF A01 CSCL 08G

Tectites (tektites) are mysterious natural acid glasses that differ dramatically from terrestrial volcanic or impact glasses. There are many arguments that speak in favor of their non-terrestrial origin, and that is why the problem of their origin has an important scientific and historical significance. It is no accident that hundreds of publications written by specialists of various fields from all over the world are devoted to this issue. It is discussed at length in a collection of articles entitled 'Tectites' (1963,1973), as well as in the excellent monograph by O'Keefe (1976). Author

N87-24858*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RETRIEVAL OF UPPER ATMOSPHERE PRESSURE-TEMPERATURE PROFILES FROM HIGH RESOLUTION SOLAR OCCULTATION SPECTRA
C. P. Rinsland, J. M. Russell, III, J. H. Park, and J. Namkung (ST Systems Corp., Hampton, Va.) May 1987 34 p
(NASA-TM-89160; NAS 1.15:89160) Avail: NTIS HC A03/MF A01 CSCL 04A

Pressure-temperature profiles over the 18 to 75 km altitude range were retrieved from 0.01 cm(-1) resolution infrared solar absorption spectra recorded with the Atmospheric Trace Molecule Spectroscopy (ATMOS) Fourier transform spectrometer operating in the solar occultation mode during the Spacelab 3 shuttle mission (April 30 to May 1, 1985). The analysis method is described and preliminary results deduced for five occultation events are compared to correlative pressure-temperature measurments. Author

N87-24616# Joint Publications Research Service, Arlington, Va.
RESULTS OF MEASURING OPTICAL THICKNESS OF ATMOSPHERE AT LINES OF OZONE'S ROTATIONAL SPECTRUM Abstract Only
Yu. Yu. Kulikov and V. G. Ryskin *In its* USSR Report: Electronics and Electrical Engineering 8 Apr. 1987 p 11 Transl. into ENGLISH from Radiotekhnia (Moscow, USSR), no. 7, Jul. 1986 p 92-93 Original language document was announced in IAA as A87-15572 (For primary document see N87-24609 18-33)
Avail: NTIS HC A05/MF A01

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N87-24859*# Florida State Univ., Tallahassee. Dept. of Meteorology.
RELATING MULTITEMPORAL METEOROLOGICAL SATELLITE DATA TO CLIMATOLOGICAL DATA FOR AFRICA Semiannual Report, Aug. 1986 - Mar. 1987
Sharon E. Nicholson Mar. 1987 4 p
(Grant NAG5-764)
(NASA-CR-180937; NAS 1.26:180937) Avail: NTIS HC A02/MF A01 CSCL 04B

The questions of surface-atmosphere interaction and effects of land surface changes have been investigated by studying the energy balance over Africa. The energy and mass balance model being developed is an adaptation of the Lettau climatonomy model. The climatonic approach is a systems approach which encompasses: (1) a process, (2) an input to the process (forcing function), (3) an output from the process (response function), (4) feedback, and (5) control or management of the system. Steady-state climate is described and parametrized using a series of one-dimensional differential continuity and balance equations for energy and mass. Author

N87-24860# National Oceanic and Atmospheric Administration, Washington, D. C. Satellite Applications Lab.
TROPICAL CYCLONE CENTER LOCATIONS FROM ENHANCED INFRARED SATELLITE IMAGERY
Jixi Jiang (National Meteorological Bureau, Beijing, China) and Vernon F. Dvorak May 1987 16 p
(NOAA-TM-NESDIS-18) Avail: NTIS HC A02/MF A01

A procedure to locate tropical cyclone centers with Enhanced Infrared (EIR) satellite imagery is presented. Schematic representations of cloud pattern centers are shown along with EIR examples to help the user select the most likely center position for any of six different cloud pattern categories. Differences between cyclone centers determined by aircraft reconnaissance fixes and those determined by using only EIR images are evaluated. These differences are then compared with the same kind of differences where the centers were operationally assigned by Miami SFSS meteorologists. The Miami SFSS meteorologists used both

visible and infrared satellite images, as well as past storm track positions. Results show that the Miami SFSS procedure made better estimates of center location. For all six cloud pattern categories combined, the average location difference (error) was 26.5 n mi for the EIR procedure compared with 22.1 n mi for the SFSS procedure. Although the average EIR location differences were about 20% larger than the SFSS differences, the EIR center positions are still very useful, especially during nightime when no visible images are available. Author

N87-24861# Institut Franco-Allemand de Recherches, St. Louis (France).
LASER DOPPLER ANEMOMETER (LDA) SYSTEM FOR LONG-RANGE CROSS-WIND VELOCITY MEASUREMENTS USING PULSED LASER RADIATION
E. Sommer and H. J. Pfeifer 2 Jun. 1986 9 p Presented at the 3rd International Symposium on Applications of Laser Anemometry to Fluid Mechanics, Lisbon, Portugal, 7-9 Jul. 1986
(Contract BMVg-T/R-760/G-0001/G-1701)
(ISL-CO-219/86; ETN-87-99639) Avail: NTIS HC A02/MF A01

A mobile laser Doppler anemometer (LDA) system is described. A pulsed Nd YAG laser was developed. With low electrical input power it delivers nearly rectangular pulses of long duration. The use of such a laser requires significant modifications of usual LDA-configurations for the optical part and in particular for the data acquisition instrumentation and for data reduction. Results over a distance of 100 m in the atmosphere using natural aerosols as wind velocity tracers are given. Under many weather conditions the signal-to-noise ratio is high enough to measure the cross-wind velocity component accurately and reliably. However, it becomes nearly impossible to get signals of sufficient quality either if the optical scintillation of the atmosphere is too high or if the particle size distribution is biased towards small particles with a diameter of less than 5 microns. ESA

N87-24862# Nevada Univ., Reno. Desert Research Inst.
EFFECTS OF CCN-FCN (CLOUD CONDENSATION NUCLEI-FOG CONDENSATION NUCLEI) SPECTRA ON DROPLET SPECTRA IN THE ALBANY FOG PROJECT Final Report, Jan. 1985 - Oct. 1986
James G. Hudson 5 Mar. 1987 203 p
(Contract DAAG29-85-K-0037)
(AD-A179776; ARO-22342.1-GS) Avail: NTIS HC A10/MF A01 CSCL 04A

Analysis of aerosol and fog droplet data has shown that fogs are composed of zones with various supersaturations and subsaturation. A technique to quantify the subsaturations as well as the supersaturations has been developed. This has enable calculations to be made of droplet growth and evaporation of the droplet spectra. These preliminary approximations are consistent with the measured time evolutions of the fog. The largest nuclei (lowest critical supersaturation) FCN were definitely found to be the only ones upon which fog droplets condense. Droplet concentrations and visibility in subsaturated conditions especially were found to be determined by the preexisting nuclei. Droplet concentrations and visibility in supersaturated conditions were found to be related to the preexisting nuclei. GRA

N87-24863# National Oceanic and Atmospheric Administration, Washington, D. C. National Environmental Satellite, Data and Information Service.
MARINERS WEATHER LOG, VOLUME 31, NUMBER 1, WINTER 1987
1987 81 p
(PB87-160693) Avail: NTIS HC A05/MF A01 CSCL 04B

The contents of the Mariners Weather Log, Winter I987, are as follows: Tales of the wild ocean; The Pride of Baltimore; North Atlantic tropical cyclones, I986; Marine observation program; and, Tips to the radio officer. GRA

N87-24864# National Severe Storms Forecast Center, Kansas City, Mo.
SEVERE THUNDERSTORM CASES OF JULY 1985 THRU JUNE 1986
J. E. Hales and H. G. Crowther Jun. 1986 84 p
(PB87-163911; NOAA-TM-NWS-NSSFC-16) Avail: NTIS HC A05/MF A01 CSCL 04B

Severe thunderstorm occurrences are relatively infrequent in much of the United States. As a result a forecaster only occasionally has an opportunity to forecast their development. This proves to be a problem as certainly one of the more important factors in forecasting them is the level of experience of the individual forecaster. Realizing the importance that experience plays and the difficulty involved for a meteorologist to study past cases, a summary was compiled of all the organized severe thunderstorm episodes for the period from July 1985 through June 1986. Included in each case were the times and locations of the severe weather along with specifics of the more noteworthy events. GRA

N87-24865# National Oceanic and Atmospheric Administration, Miami, Fla. Oceanographic and Meteorological Labs.
ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY, FISCAL YEAR 1986 Annual Report
Jan. 1987 49 p
(PB87-164281) Avail: NTIS HC A03/MF A01 CSCL 04B

The Atlantic Oceanographic and Meteorological Laboratory Report for Fiscal 1986 contains the following: the AOML FY-1986 annual report; FY-I986 accomplishments/FY-1987 plans (climate research, weather observation and prediction, air quality, marine resources, marine observation and prediction); and FY-1986 publications. GRA

N87-24866*# National Aeronautics and Space Administration, Washington, D.C.
THE CLASSIFICATION OF WIND SHEARS FROM THE POINT OF VIEW OF AERODYNAMICS AND FLIGHT MECHANICS
Fritz Seidler and Gunter Hensel May 1987 23 p Transl. into ENGLISH from Technisch-Oekonomische Information der Zivilen Luftfahrt (East Germany), v. 22, no. 3-4, 1986 p 107-112 Original language document was previously announced in IAA as A87-11898 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4005)
(NASA-TT-20020; NAS 1.77:20020; ISSN-0232-5012) Avail: NTIS HC A02/MF A01 CSCL 04B

A study of international statistical data shows that in about three quarters of all serious accidents which occurred with jet propelled airliners wind shear was either one of the main causes of the accident or represented a major contributory cause. Wind shear related problems are examined. The necessity of a use of different concepts, definitions, and divisions is explained, and the concepts and definitions required for the division of wind and wind shear into different categories is discussed. A description of the context between meteorological and aerodynamics-flight mechanics concepts, definitions, and divisions is also provided. Attention is given to wind and wind components, general characteristics of wind shear and the meteorological terms, the basic types of wind shear for aerodynamics-flight mechanics investigations, special types of wind shear for aerodynamics-flight mechanics investigations, and possibilities regarding a change of the wind component. Author

N87-24867# British Library Lending Div., Boston Spa (England).
THE INTERPRETATION OF SATELLITE IMAGES BY SYNOPTIC ANALYSIS AND DIAGNOSIS
Manfred Kurz [1986] 10 p Transl. into ENGLISH from Meteorologische Rundschau (West Germany), v. 39, no. 5, Oct. 1986 p 145-151 Original language document was announced in IAA as A87-26187
(BLL-MO-Trans-1641-(9022.552)) Avail: British Library Lending Div., Boston Spa, Engl.

Using a case study, the possibilities and problems arising from the use of satellite images in synoptic work are discussed. In the

weather situation shown, a relative movement occurs between the higher cloud visible in the IR-images and a frontal system near the surface. Overlooking this feature would have led to an extremely wrong analysis of the surface fronts. The relative movement is part of a typical cyclonic development. At the end the cloud structure of the frontal system changes quickly due to the release of potential instability. Author

N87-24868# Meteorological Satellite Center, Tokyo (Japan). System Engineering Div.
RENEWAL PLAN OF COMPUTER SYSTEM AND TELECOMMUNICATION FACILITIES AT METEOROLOGICAL SATELLITE CENTER
T. Hamada, ed. Mar. 1987 208 p
(MSC-TN-15; ISSN-0388-9653) Avail: NTIS HC A10/MF A01

The current computer system at DPC was replaced by a new computer system in March 1987. The new computer system was installed in order to be used for system check-out for six months before it begins routine operation. Hourly basis imaging in Northern Hemisphere started at that time. Following the computer replacement, the telecommunication facilities at CDAS and DPC will be replaced with new ones in March 1988. Stretched VISSR dissemination for all VISSR observations will start at this time, and HR-FAX transmission through satellite will be quit in a few months after March 1988. The renewal plan of the DPC computer system, which is going on, and the coming renewal plan of the telecommunication ground facilities are described. Chapters are entitled: New computer system and products of Meteorological Satellite Center; Renewal plan of the ground telecommunication facilities; and Future schedule of VISSR observation and FAX dissemination. Author

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N87-24869 Defence Research Information Centre, Orpington (England).
MEASURED RADIATION AND HEAT FLUXES AT THE TROPICAL OCEAN SURFACE
H. Grassl Dec. 1986 21 p Transl. into ENGLISH from Meteor Forsch-Ergebnisse (West Germany), Reihe B, no. 12, Dec. 1977 p 42-50
(DRIC-T-7815; BR101098; ETN-87-99826) Copyright Avail: NTIS Issuing Activity

The net flux of all irreversible fluxes of radiation and heat crossing the ocean surface is determined for GARP Altantic Tropical Experiment phase 3 at position 27. The radiation fluxes were measured directly, while the heat fluxes were parameterized with the bulk formula, however with bulk coefficients depending on stability. The heat loss of the ocean due to warming of the cooler precipitation is included for the determination of the net flux at the ocean surface. Examples of hourly mean values of different fluxes during different weather conditions are shown. ESA

N87-24870* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ARCTIC SEA ICE, 1973-1976: SATELLITE PASSIVE-MICROWAVE OBSERVATIONS
Claire L. Parkinson, Josefino C. Comiso, H. Jay Zwally, Donald J. Cavalieri, Per Gloersen, and William J. Campbell (Puget Sound Univ., Tacoma, Wash.) Jan. 1987 301 p Original contains color illustrations
(NASA-SP-489; NAS 1.21:489; LC-86-23876) Avail: NTIS HC A14 CSCL 08L

The Arctic region plays a key role in the climate of the earth. The sea ice cover affects the radiative balance of the earth and radically changes the fluxes of heat between the atmosphere and the ocean. The observations of the Arctic made by the Electrically Scanning Microwave Radiometer (ESMR) on board the Nimbus 5 research satellite are summarized for the period 1973 through 1976. B.G.

N87-24871# National Center for Atmospheric Research, Boulder, Colo.
NUMERICAL STUDY OF THE RESPONSE OF THE SOUTHERN OCEAN AND ITS SEA ICE TO A CO2-INDUCED ATMOSPHERIC WARMING
J. P. vanYpersele 1986 153 p Prepared in cooperation with Universite Catholique de Louvain, Belgium
(Grant NSF ATM-82-17015)
(PB87-163218; NCAR/CT-99) Copyright Avail: NTIS HC A08/MF A01 CSCL 08C

A comprehensive coupled model of ocean circulation and sea ice has been developed to study a selected area of the Southern Ocean that includes the Weddell Sea and the Drake Passage. An existing general circulation model of the ocean was configured for the geometry of the Southern Ocean domain and then improved by including robust-diagnostic forcing and allowing for coupling to a sea-ice model. When the model was initially tested without coupling, the ocean circulation corresponded well with the observed circulation. In addition, a dynamic-thermodynamic model of sea ice was developed and tested with a constant upward oceanic heat flux. The results of two simulations made with the sea-ice model, with and without transport and dynamics, show that thermodynamics is insufficient to explain the large amplitude of the seasonal cycle of ice extent, and that the inclusion of transport and parameterized dynamics is essential for the reproduction of the observed cycle. GRA

N87-24730# Joint Publications Research Service, Arlington, Va.
WIND, KUROSHIO SYSTEM ACTION ON EAST CHINA SEA CIRCULATION
Fengshu Liu *In its* China Report: Science and Technology 2 May 1986 p 41-47 Transl. into ENGLISH from Haiyang Kexue (Beijing, China), v. 9, no. 3, 9 May 1985 p 1-4 (For primary document see N87-24729 18-42)
Avail: NTIS HC A05/MF A01

N87-24731# Joint Publications Research Service, Arlington, Va.
HIGH RESOLUTION SEA SURFACE TEMPERATURE FIELD DERIVED
Sisong Zhou, Weiying Chen, and Lixia Zhang *In its* China Report: Science and Technology 2 May 1986 p 48-55 Transl. into ENGLISH from Haiyang Kexue (Beijing, China), v. 9, no. 3, 9 May 1985 p 5-9 (For primary document see N87-24729 18-42)
Avail: NTIS HC A05/MF A01

N87-24960# Joint Publications Research Service, Arlington, Va.
SCHEME FOR TYPHOON WAVE CALCULATION IN NORTHERN PART OF SOUTH CHINA SEA
Jinghan Zhang and Shaoying Li *In its* China Report: Science and Technology 2 Sep. 1986 p 13-48 Transl. into ENGLISH from Nanhai Haiyang Kexue (Beijing, China), no. 1, May 1980 p 135-164 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

51 LIFE SCIENCES (GENERAL)

N87-24872# Chemical Research and Development Center, Aberdeen Proving Ground, Md.
THERMOPHILIC AND HALOPHILIC ENZYMES Technical Report, Jun. 1984 - Jan. 1986
Kenneth Mioduski and William E. White Feb. 1987 23 p
(AD-A179058; CRDEC-TR-87029) Avail: NTIS HC A02/MF A01 CSCL 06A

Some species of microorganisms survive under heat and saline conditions that would denature the proteins of less tolerant counterparts. In this report, we analyze numerous small changes in a class of proteins from thermophilic and halophilic bacteria to

elucidate the biochemical traits that confer stability. Major advances in chemical-biological detection and contamination control depend on the proper functioning of proteins such as antibodies, enzymes, and receptor sites. If protein-based detectors and decontaminants are to reach the soldier in the field, the biomolecules will have to be heat- and salt-tolerant. Knowledge of how naturally resistant molecules achieve their stability will enable biotechnologists to introduce precise stabilizing characteristics into needed, but otherwise fragile, proteins. GRA

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N87-24873# Naval Health Research Center, San Diego, Calif.
EFFECT OF AEROBIC TRAINING ON THE PLASMA ACTH RESPONSE TO EXERCISE Interim Report
Michael J. Buono, John E. Yeager, and Anthony A. Sucec 1 Sep. 1986 9 p
(AD-A178430; NAVHLTHRSCHC-86-28) Avail: NTIS HC A02/MF A01 CSCL 06N

The purpose of this study was to re-examine the effect of training on plasma ACTH levels during exercise. Ten adult volunteers were split into a control and an experimental group. The experimental group participated in a 12-week training program which resulted in a significant 11% increase in their mean maximal oxygen uptake. The plasma ACTH response to a 150W workload was measured in both groups before and after the training program. The experimental group demonstrated a significant reduction in the delta ACTH response to the workload, while the control group demonstrated an unchanged response over the course of the study. These data suggest that the ACTH response to an absolute, submaximal workload is blunted following training. Such a finding is in agreement with previous studies that have shown that ACTH follows an intensity dependent pattern during exercise. GRA

N87-24874* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PHOTOREFRACTOR OCULAR SCREENING SYSTEM Patent
John R. Richardson, inventor (to NASA) and Joseph H. Kerr, inventor (to NASA) (Medical Sciences Corp., Huntsville, Ala.) 2 Jun. 1987 11 p Filed 28 Sep. 1984 Supersedes N85-20639 (23 - 11, p 1692)
(NASA-Case-MFS-26011-1-SB; US-Patent-4,669,836; US-Patent-Appl-SN-655605; US-Patent-Class-351-206; US-Patent-Class-354-62; US-Patent-Class-351-208) Avail: US Patent and Trademark Office CSCL 06P

A method and apparatus for detecting human eye defects, particularly detection of refractive error is presented. Eye reflex is recorded on color film when the eyes are exposed to a flash of light. The photographs are compared with predetermined standards to detect eye defects. The base structure of the ocular screening system is a folding interconnect structure, comprising hinged sections. Attached to one end of the structure is a head positioning station which comprises vertical support, a head positioning bracket having one end attached to the top of the support, and two head positioning lamps to verify precise head positioning. At the opposite end of the interconnect structure is a camera station with camera, electronic flash unit, and blinking fixation lamp, for photographing the eyes of persons being evaluated.
Official Gazette of the U.S. Patent and Trademark Office

N87-24875# Joint Publications Research Service, Arlington, Va.
USSR REPORT: LIFE SCIENCES. BIOMEDICAL AND BEHAVIORAL SCIENCES
10 Mar. 1987 88 p Transl. into ENGLISH from various Russian articles
(JPRS-UBB-87-006) Copyright Avail: NTIS HC A05/MF A01

Topics addressed include: aerospace medicine; biochemistry; biotechnology; radiations effects; genetics; clinical medicine; microbiology; immunology; toxicology; pharmacology; physiology; and public health. For individual titles, see N87-24876 through N87-24876.

N87-24876# Joint Publications Research Service, Arlington, Va.
STUDY OF MUSCLE BIOENERGETICS IN WEIGHTLESSNESS
E. S. Mailyan, E. A. Kovalenko, and L. V. Buravkova *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences 10 Mar. 1987 p 1-7 Transl. into ENGLISH from Patologicheskaya Fiziologiya i Eksperimentalnaya Terapiya (Moscow, USSR), no. 5, Sep. - Oct. 1985 p 69-73 (For primary document see N87-24875 18-52)
Copyright Avail: NTIS HC A05/MF A01

The parameters of oxidative phosphorylation and the activity of cytochrome oxidase and lactate dehydrogenase were studied in the skeletal muscles of rats exposed on 3 biosputniks of the Kosmos series. An 18 to 22 day space flight leads to marked inhibition of oxidative metabolism and glycolysis in skeletal muscles of different morphofunctional specializations, disorders of oxidative phosphorylation conjugation and reduced activity of the studied enzymes. Muscular tissue respiration was restored by the end of the first month of the readaptation period. The need for studying the bioenergetic processes in skeletal muscles is emphasized by the fact that the muscular system, which plays a major role in energy and heat formation processes of the body, is also one of the main targets affected by weightlessness. The pathogenic mechanisms of functional muscular insufficiency in the postflight period are still not understood completely. The processes of oxidative phosphorylation and the activities of certain oxidative enzymes in the skeletal muscles of albino rats were investigated at various times in the postflight period. Author

N87-24877# Navy Experimental Diving Unit, Panama City, Fla.
REPEATED MEASUREMENT OF DIVERS' WORD FLUENCY Final Report
Robert C. Carter, Michael D. Curley, and David J. Styer Apr. 1987 26 p
(AD-A179965; NEDU-3-87) Avail: NTIS HC A03/MF A01 CSCL 06E

Word Fluency is an aspect of human behavior that can be a useful indicator of possible neurological effects of long, deep undersea diving, acute decompression sickness, and arterial gas embolism. Testing of divers' Work Fluency before, during, and after dives requires availability of multiple, equivalent but different tests of Word Fluency. This report describes the procedures used to develop and evaluate Word Fluency test forms suitable for repeated measurement experimental designs. Alternate, parallel forms of a Word Fluency test are recommended. Results are presented of illustrative measurements of Word Fluency before, during, and after 30-day saturation dives to simulated depths of 259m and 335m, and of follow-up measurements of a central nervous system decompression sickness case. These results indicate that a Word Fluency test could be a sensitive indicator of environmental stress. Normative data for divers using several letters are presented. GRA

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N87-24878# Sequoia Associates, Inc., Arlington, Va.
A SEARCH FOR POSITIVE RESPONSE LEVEL INDICATORS (PRLI'S) UNDER STRESS Final Report, 1 Oct. 1984 - 2 Mar. 1987
J. M. Murray Mar. 1987 166 p
(Contract EMW-84-C-1557)
(AD-A178373) Avail: NTIS HC A08/MF A01 CSCL 05J

Effective economic and human resources planning requires quantitative knowledge of human response levels under stress. In this project, the Essential Workers' Supportiveness Index was designed and tested as an instrument for measuring the positive

response levels of a population's willingness to support overall national emergency. The theoretical basis of the research was Gittinger's Personality Assessment System (PAS), augmented by Saunders' PAS-derived Fourth Dimension. The EWSI made use of these concepts, and it is suitable for mass testing. It was administered to a sample of 1530 subjects from two geographic areas and included 23 categories of essential workers. Four primary types of stress-related behaviors were identified: Phlegmatic and Egocentric, which were unsupportive (80.6 percent). Training modalities were devised to improve supportiveness (positive response levels) in all four types of behaviors. Recommendations for further testing were made. Report contains a Spectrum of Emergencies, a Bibliography on Economic Stabilization, and a Bibliography on the Personality Assessment System. GRA

N87-24879# Universidade Nova de Lisboa (Portugal). Lisboa (portugal).

DECREASING DAMAGING EFFECTS OF STRESS-BOUND SITUATIONS: TOWARDS A NEW MODEL OF LEADERSHIP UNDER STRESS Interim Report, Nov. 1985 - Oct. 1986

Orlindo Pereira and Jorge Jesuino Jan. 1987 73 p

(Contract DAJA45-85-C-0036; DA Proj. 2Q1-61102-B-74-F)

(AD-A178379; ARI-RN-87-01) Avail: NTIS HC A04/MF A01 CSCL 05J

In jobs or tasks where no possibility exists to avoid stress (e. g. combat action) repeated exposure is likely to produce relatively permanent damage in groups or individuals. Previous research demonstrated this fact in the case of marines involved in counter-guerrilla activity. Pereira and Jesuino (1982, using Fiedler's model as a framework, have shown that appropriate leadership can buffer the consequences of stress. To understand how such an effect comes about, the authors developed and began test on a model of leadership-group transactions. The results of this field study show that leadership has a significant bearing on the stressors strain interface. Bureaucratic expertise is a prerequisite for leader and subordinates' acceptance of one another. Continuation of the research and some practical applications of the findings are discussed. GRA

N87-24880# Aircraft Owners and Pilots Association, Frederick, Md.

AERONAUTICAL DECISION MAKING FOR INSTRUMENT PILOTS Final Report

Richard S. Jensen, Janeen Andrion, and Russell S. Lawton May 1987 91 p

(Contract DTFA01-80-C-10080)

(DOT/FAA/PM-86/43) Avail: NTIS HC A05/MF A01

Aviation accident data indicate that the majority of aircraft mishaps are due to judgement error. This training manual is part of a project to develop materials and techniques to help improve pilot decision making. Training programs using prototype versions of these materials have demonstrated substantial reductions in pilot error rates ranging from approximately 10 to 50% fewer mistakes. This manual is designed to explain the risks associated with instrument flying activities, the underlying behavioral causes of typical accidents, and the effects of stress on pilot decision making. It provides a means for the individual pilot to develop an Attitude Profile through a self-assessment inventory and provides detailed explanations of preflight and in-flight stress management techniques. The assumption is that the pilots will develop a positive attitude toward safety and the ability to effectively manage stress while recognizing and avoiding unnecessary risk. The manual is one of a series on Aeronautical Decision Making prepared for the following pilot audiences: (1) Student and Private; (2) Commercial; (3) Instrument; (4) Instructor; (5) Helicopter; and (6) Multi-Crew.

Author

N87-24881# Aircraft Owners and Pilots Association, Frederick, Md. Program Engineering and Maintenance Service.

AERONAUTICAL DECISION MAKING FOR INSTRUCTOR PILOTS

Georgette Buch, ed., Russell S. Lawton, ed., and Gary S. Livack, ed. May 1987 73 p

(Contract DTFA01-80-C-10080)

(DOT/FAA/PM-86/44) Avail: NTIS HC A04/MF A01

Aviation accident data indicate that the majority of aircraft mishaps are due to judgment error. This training manual is part of a project to develop materials and techniques to help improve pilot decision making. Training programs using prototype versions of these materials have demonstrated substantial reductions in pilot error rates, ranging from approximately 10% to 50% fewer mistakes. This manual is designed to explain the risks associated with flight instruction activities, the underlying behavioral causes of typical accidents, and the effects of stress on pilot decision making. It teaches judgment concepts in contrast to the imparting of knowledge and the development of airmanship skills in conventional flight training. It also provides detailed explanations of pre-flight and in-flight stress management techniques.The assumption is that CFI's receiving this training will develop a positive attitude toward safety and the ability to effectively manage stress while recognizing and avoiding unnecessary risk. The manual is one of a series of Aeronautical Decision Making prepared for the following pilot audiences: (1) Student and Private; (2) Commercial; (3) Instrument; (4) Instructor; (5) Helicopter; and (6) Multi-Crew.

Author

N87-24882*# Johns Hopkins Univ., Baltimore, Md. School of Medicine.

BEHAVIORAL AND BIOLOGICAL INTERACTIONS WITH SMALL GROUPS IN CONFINED MICROSOCIETIES Final Report

Joseph V. Brady Nov. 1986 39 p

(Grant NAG2-139)

(NASA-CR-181012; NAS 1.26:181012) Avail: NTIS HC A03/MF A01 CSCL 05I

Research on small group performance in confined microsocieties was focused upon the development of principles and procedures relevant to the selection and training of space mission personnel, upon the investigation of behavioral programming, preventive monitoring and corrective procedures to enhance space mission performance effectiveness, and upon the evaluation of behavioral and physiological countermeasures to the potentially disruptive effects of unfamiliar and stressful environments. An experimental microsociety environment was designed and developed for continuous residence of human volunteers over extended time periods. Studies were then undertaken to analyze experimentally: (1) conditions that sustain group cohesion and productivity and that prevent social fragmentation and performance deterioration, (2) motivational effects performance requirements, and (3) behavioral and physiological effects resulting from changes in group size and composition. The results show that both individual and group productivity can be enhanced under such conditions by the direct application of contingency management principles to designated high-value tasks. Similarly, group cohesiveness can be promoted and individual social isolation and/or alienation prevented by the application of contingency management principles to social interaction segments of the program. M.G.

N87-25051# Glasgow Univ. (Scotland). Dept. of Physics and Astronomy.

THE IMPACT OF THE COSMOS ON THE HUMAN RACE

Archie E. Roy *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 149-151 (For primary document see N87-25026 18-89)

Copyright Avail: NTIS HC A20/MF A01

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

N87-24883# Factor-H, Inc., Tempe, Ariz.
PHYSIOLOGICAL ASSESSMENT OF PILOT WORKLOAD IN THE A-7 AIRCRAFT Final Technical Paper, Jan. 1984 - Jul. 1985
Ernest Lindholm, Norwood Sisson, Milton J. Miller, and Margaret E. Toldy Apr. 1987 30 p Prepared in cooperation with Interface Research Associates, Inc., Scottsdale, Ariz.
(Contract F33615-81-C-0005)
(AD-A178937; AFHRL-TP-86-25) Avail: NTIS HC A03/MF A01 CSCL 06S

Custom hardware and software were developed to permit the inflight recording of as many as 23 aircraft parameters,and the heart and respiration activity of a pilot flying an A-7 aircraft. G-forces, altitude, and velocity were systematically manipulated in three environments which differed with respect to the quality of visual cues for depth perception. The results showed that heart rate was most sensitive to changes in altitude, somewhat less sensitive to changes in velocity, and least sensitive to G-forces. Heart rate was also sensitive to the visual cue quality of the environment, but only for maneuvers performed at low altitude. Respiration activity covaried with changes in aircraft parameters, but this relationship could be detected only by multivariate analysis techniques. In some cases, heart rate did not show the predicted increases, and it is suggested that rapid changes in blood pressure would be valuable to assess in future investigations. GRA

N87-24884# Joint Publications Research Service, Arlington, Va.
USSR REPORT: LIFE SCIENCES. BIOMEDICAL AND BEHAVIORAL SCIENCES
18 Feb. 1987 98 p Transl. into ENGLISH from various Russian articles
(JPRS-UBB-87-004) Avail: NTIS HC A05/MF A01

Topics addressed include: aerospace medicine; biochemistry; genetics; biophysics; clinical medicine; microbiology; pharmacology; toxicology; and physiology. For individual titles, see N87-24885 through N87-24885.

N87-24885# Joint Publications Research Service, Arlington, Va.
CHANGES IN HUMAN BODY FUNCTIONS UPON INGESTION OF READY MADE FOOD CONCENTRATES
E. P. Tsyganov, A. N. Agureyev, Ye. V. Kolchin, V. S. Dupik, and A. A. Gubernatorov *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences 18 Feb. 1987 p 37-41 Transl. into ENGLISH from Voprosy Pitaniya (Moscow, USSR), no. 1, Jan. - Feb. 1986 p 30-33 (For primary document see N87-24884 18-54)
Avail: NTIS HC A05/MF A01

When making small size rations (SSR) for individual needs, ready for use or for emergency stock, it is necessary to consider several factors. Of these the three most important are: the necessity to contain energy and nutrition rich food in a small unit mass; the length of time and convenience of storage, and the durability and reliability of the packaging. Developing and improving an SSR with an optimal ratio of basic food ingredients is an urgent unresolved problem of food hygiene. Changes in the body function of volunteers who consumed ready-to-use food concentrate briquettes packed as a single-portion SSRs were studied. The experimental results served as proof that there were no changes in health and no significant alteration in the studied functional indexes of the subjects maintained for 3 days on a diet of SSRs, in ready-made concentrated briquettes designed for individual use. Author

N87-24886 Virginia Polytechnic Inst. and State Univ., Blacksburg.
EFFECTS OF VISUAL DISPLAY AND MOTION SYSTEM DELAYS ON OPERATOR PERFORMANCE AND UNEASINESS IN A DRIVING SIMULATOR Ph.D. Thesis
Lawrence Henry Frank 1986 247 p
Avail: Univ. Microfilms Order No. DA8704673

The role of visual-motion coupling delays and cueing order on operator performance and uneasiness were assessed in a driving simulator by means of a response surface methodology (RSM) central-composite design. Three levels of visual delay and three levels of motion delay were completely crossed in the two-factor, between-subjects, central-composite design. Six subjects were assigned to each of the nine treatment conditions based upon pretest scores on the rod-and-frame test and under the constraint that an equal number of males and females were assigned to each treatment. The most salient finding was that visual delay appears to be more disruptive to an individual's control performance and well-being than is motion delay. Empirical multiple regression models were derived to predict 10 reliable measures of simulator operator driving performance and comfort. Principal components analysis on these 10 models decomposed the dependent measures into two significant models which were labeled vestibular disruption and degraded performance. A secondary analysis of the role of subject gender and perceptual style on susceptibility to simulator sickness revealed that neither of these independent variables was a significant source of variance.
Dissert. Abstr.

N87-24887# Monash Univ., Clayton (Australia). Human Factors Group.
HUMAN FACTORS IN COMMAND-AND-CONTROL SYSTEM PROCUREMENT
Conn V. Copas, Thomas J. Triggs, and Jeremy G. Manton Dec. 1985 158 p
(HFR-15; ISBN-0-86746-312-0) Avail: NTIS HC A08/MF A01

A review is presented of various human factors engineering techniques that could be used at the early stages of a procurement program for computer based tactical information systems. The various stages of the program are discussed with regard to the prominent human factors issues that should be addressed. Some recommendations are made concerning the management of procedures for implementing human factors and some study topics are suggested for short term projects in a research institution. Two appendices are included. Appendix A deals with issues related to user involvement in the design process and Appendix B outlines some studies that have examined human factors issues in design programs. Guidance is provided concerning the types of methods used to promote decisions relating to the human factors aspects that will enhance system performance at all phases of development of a well engineered workplace for the human operator. Author

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

N87-24888*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
[RESEARCH CONDUCTED AT THE INSTITUTE FOR COMPUTER APPLICATIONS IN SCIENCE AND ENGINEERING IN APPLIED MATHEMATICS, NUMERICAL ANALYSIS AND COMPUTER SCIENCE] Semiannual Report, 1 Oct. 1986 - 31 Mar. 1987
May 1987 66 p
(Contract NAS1-18107)
(NASA-CR-178314; NAS 1.26:178314) Avail: NTIS HC A04/MF A01 CSCL 12A

Research conducted at the Institute for Computer Applications in Science and Engineering in applied mathematics, numerical analysis, and computer science during the period October 1, 1986 through March 31, 1987 is summarized. Author

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N87-24889# Fraunhofer-Inst. fuer Festkoerpertechnologie, Munich (West Germany).
ASSESSMENT AND EVALUATION OF SPACE-REDUCING, DYNAMIC MEMORY-CELL CONCEPTS Final Report, Sep. 1985
Horst Gieser, Siegfried Irl, and Ingolf Ruge Bonn, West Germany BMFT Dec. 1986 54 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-117; ISSN-0340-7606; ETN-87-99703) Avail: NTIS HC A04/MF A01; Fachinformationsznetrum, Karlsruhe, West Germany DM 11

The most promising concepts for memories with several Mbits, the stacked-capacitor cell and the corrugated-capacitor cell, were examined starting from a classifying summary of all cell concepts in the scientific literature. The discrete development of the self-amplifying memory cell BISO is explained, and all three-dimensional cell concepts are discussed. The various concepts for write-read systems were evalvated. The sense amplifier is shown to have a considerable importance; therefore, an NMOS sense amplifier with full-VDD bit line precharge, and a CMOS sense amplifier with half-VDD precharge were characterized using a SPICE simulation. ESA

N87-24890# Karlsruhe Univ. (West Germany). Forschungszentrum Informatik.
DESIGN OF A DATA BASE COMPUTER BASED ON A MULTIMICROPROCESSOR SYSTEM Final Report, Dec. 1985
Marcus Adams, Guenter vonBueltzingsloewen, Klaus Huthmacher, and Rolf-Peter Liedtke Bonn, West Germany BMFT Dec. 1986 40 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-DV-86-007; ISSN-0170-9011; ETN-87-99704) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 8

Basic concepts for the hardware and software architecture of a backend data-base computer based on a multimicrocomputer system are presented. The starting point was an analysis of the requirements for the data management systems in process automation applications. Salient features of the hardware architecture are that several autonomous computer units are grouped into clusters, and that clusters are interconnected by a duplicated bus system which allows independent transmissions on both busses in case of no failure. If one bus fails, transmissions via the other are still possible. Another duplicated bus system was designed for the connection of peripheral components to the clusters. Basic concepts of the software architecture are the functional decomposition of the data base management system, the control of software functions by data flow mechanisms, and the strictly set-oriented processing of data base operations. ESA

N87-24948# Naval Air Development Center, Warminster, Pa.
MACHINE ARCHITECTURES FOR ARTIFICIAL INTELLIGENCE COMPUTING
Raymond P. Kirsch and Christof H. Heithecker *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 11 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N87-24891# Massachusetts Univ., Amherst. Dept. of Computer and Information Science.
REPRESENTATION AND CONTROL IN THE INTERPRETATION OF COMPLEX SCENES Final Scientific Report, 1 Oct. 1984 - 30 Sep. 1985
Allen R. Hanson and Edward M. Riseman 1987 61 p
(Contract F49620-83-C-0099; Grant AF-AFOSR-0005-85)
(AD-A179116; AFOSR-87-0301TR) Avail: NTIS HC A04/MF A01 CSCL 09B

The system being developed, called VISIONS, is an investigation into issues of general computer vision. The goal is to provide an analysis of color images of outdoor scenes, from segmentation through symbolic interpretation. The output of the system is intended to be a symbolic representation of the three-dimensional world depicted in the two-dimensional image, including the naming of objects, their placement in three-dimensional space, and the ability to predict from this representation the rough appearance of the scene from other points of view. The emphasis of the research over the past year has been on three issues critical to furthering our understanding of machine vision. The first area addresses the issue of image segmentation and the failure of recent research to provide robust procedures applicable to complex imagery. The second area focusses on the use of domain knowledge in the interpretation task. The third area focusses on techniques for controlling the use of system resources during interpretation and on ways of resolving conflicting partial interpretations. GRA

N87-24892# California Univ., Los Angeles. Management Science Inst.
INTEGRATED MODELING SYSTEMS
Arthur M. Geoffrion Nov. 1986 19 p
(Contract N00014-75-C-0570)
(AD-A179132) Avail: NTIS HC A02/MF A01 CSCL 09B

This paper examines in some detail the concept of an integrated modeling system. Three main types of integration are distinguished: model integration, solver integration, and integration of various utilities. Model integration is further divided into four subtypes based on a four-level model abstraction hierarchy: specific models, model classes, modeling paradigms, and modeling traditions. The paper then goes on to consider how structured modeling supports the various types of integration. The overall conclusion is that the structured modeling approach offers an attractive approach to the design of integrated modeling systems. GRA

N87-24893# California Univ., Los Angeles. Management Science Inst.
MODELING APPROACHES AND SYSTEMS RELATED TO STRUCTURED MODELING
Arthur M. Geoffrion Feb. 1987 31 p
(Contract N00014-75-C-0570)
(AD-A179149; WMSI-WP-339) Avail: NTIS HC A03/MF A01 CSCL 09B

(AD-A179149; WMSI-WP-339) Avail: NTIS HC A03/MF A01 CSCL 09B

This companion to the author's paper, An Introduction to Structured Modeling, discusses modeling approaches by other authors and some of the modeling systems available as alternatives for at least some of the functions to which a structured modeling system aspires. It is an expansion of the brief discussion of this topic in the mentioned paper, with which the reader is assumed to be familiar. The categories of discussion are: (1) Relational database systems; (2) GAMS (General Algebraic Modeling System); (3) PLATOFORM (Planning Tool Written in DATA FORM); (4) Other modern mathematical programming systems; (5) IFPS and OPTIMUM; (6) ANALYTICOL; (7) Conceptual graphs; (8) Discrete event simulation; (9) Graph grammar-based systems; and (10) Special purpose systems. GRA

N87-24894# Carnegie-Mellon Univ., Pittsburgh, Pa. Management Sciences Research Group.

SEQUENTIAL CONVEXIFICATION IN REVERSE CONVEX AND DISJUNCTIVE PROGRAMMING

Egon Balas, Joseph M. Tama, and Jorgen Tind Dec. 1986 26 p

(Contract N00014-82-K-0329; Grant NSF ECS-82-05425)

(AD-A179157; MSRR-531) Avail: NTIS HC A03/MF A01 CSCL 12B

This paper is about a property of certain combinatorial structures, called sequential convexifiability, shown by Balas 1974, 1979 to hold for facial disjunctive programs. Sequential convexifiability means that the convex hull of a nonconvex set defined by a collection of constraints can be generated by imposing the constraints one by one, sequentially, and generating each time the convex hull of the resulting set. This document extends the class of problems considered to disjunctive programs with infinitely many terms, also known as reverse convex programs, and give necessary and sufficient conditions for the solution sets of such problems to be sequentially convexifiable. The authors point out important classes of problems in addition to facial disjunctive programs (for instance, reverse convex programs with equations only) for which the conditions are always satisfied. Finally, given, are examples of disjunctive programs for which the conditions are violated, and so the procedure breaks down. GRA

N87-24895*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

COLLECTED SOFTWARE ENGINEERING PAPERS, VOLUME 2

Nov. 1983 223 p

(NASA-TM-89371; SEL-83-003-Vol-2; NAS 1.15:89371) Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

Topics addressed include: summaries of the software engineering laboratory (SEL) organization, operation, and research activities; results of specific research projects in the areas of resource models and software measures; and strategies for data collection for software engineering research. For individual titles, see N87-24896 through N87-24904.

N87-24896*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MEASURING SOFTWARE TECHNOLOGY

W. W. Agresti, D. N. Card, V. E. Church, G. Page (Computer Sciences Corp., Silver Spring, Md.), and F. E. McGarry *In its* Collected Software Engineering Papers, Volume 2 Nov. 1983 5 p (For primary document see N87-24895 18-61)

Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

Results are reported from a series of investigations into the effectiveness of various methods and tools used in a software production environment. The basis for the analysis is a project data base, built through extensive data collection and process instrumentation. The project profiles become an organizational memory, serving as a reference point for an active program of measurement and experimentation on software technology. Author

N87-24897*# Maryland Univ., College Park.

[SOFTWARE DEVELOPMENT PREDICTORS, ERROR ANALYSIS, RELIABILITY MODELS AND SOFTWARE METRIC ANALYSIS] Technical Report, 1982

Victor Basili *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 14 p (For primary document see N87-24895 18-61)

(Grant NGL01-526-104)

Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

The use of dynamic characteristics as predictors for software development was studied. It was found that there are some significant factors that could be useful as predictors. From a study on software errors and complexity, it was shown that meaningful results can be obtained which allow insight into software traits and the environment in which it is developed. Reliability models were studied. The research included the field of program testing because the validity of some reliability models depends on the answers to some unanswered questions about testing. In studying software metrics, data collected from seven software engineering laboratory (FORTRAN) projects were examined and three effort reporting accuracy checks were applied to demonstrate the need to validate a data base. Results are discussed. B.G.

N87-24898*# Computer Sciences Corp., Silver Spring, Md.

COMPARISON OF REGRESSION MODELING TECHNIQUES FOR RESOURCE ESTIMATION

D. N. Card *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 21 p (For primary document see N87-24895 18-61)

(Contract NAS5-27555)

Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

The development and validation of resource utilization models is an active area of software engineering research. Regression analysis is the principal tool employed in these studies. However, little attention was given to determining which of the various regression methods available is the most appropriate. The objective of the study is to compare three alternative regession procedures by examining the results of their application to one commonly accepted equations for resource estimation. The data studied was summarized, the resource estimation equation was described, the regression procedures were explained, and the results obtained from the proceures were compared. Author

N87-24899*# Computer Sciences Corp., Silver Spring, Md.

EARLY ESTIMATION OF RESOURCE EXPENDITURES AND PROGRAM SIZE

D. Card *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 23 p (For primary document see N87-24895 18-61)

(Contract NAS5-24300)

Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

A substantial amount of software engineering research effort was focused on the development of software estimation models. A measure of lines of code was derived based on the origin of the delivered code, L sub dev = N + E + 0.2 (S + O) (where L sub dev = developed lines of code, N = newly implemented lines of code, E = extensively modified lines of code, S = slightly modified lines of code, and O = old unchanged lines of code) that is substituted in the following equation H sub s = aL sup b (where H sub s = staff-hours of effort, L = lines of code, a = a constant, and b = a constant). The limitations of this model are discussed and some alternative estimation models that can be used earlier in the development process are proposed. B.G.

N87-24900*# Maryland Univ., College Park. Dept. of Computer Science.
METRIC ANALYSIS AND DATA VALIDATION ACROSS FORTRAN PROJECTS
Victor R. Basili, Richard W. Selby, Jr., and Tsai-Yun Phillips *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 40 p (For primary document see N87-24895 18-61)
(Grants NsG5-123; F49620-80-C-001)
(TR-1228) Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

The desire to predict the effort in developing or explaining the quality of software has led to the proposal of several metrics. As a step toward validating these metrics, the Software Engineering Laboratory (SEL) has analyzed the software science metrics, cyclomatic complexity, and various standard program measures for their relation to effort (including design through acceptance testing), development errors (both discrete and weighted according to the amount of time to locate and fix), and one another. The data investigated are collected from a project FORTRAN environment and examined across several projects at once, within individual projects and by reporting accuracy checks demonstrating the need to validate a database. When the data comes from individual programmers or certain validated projects, the metrics' correlations with actual effort seem to be strongest. For modules developed entirely by individual programmers, the validity ratios induce a statistically significant ordering of several of the metrics' correlations. When comparing the strongest correlations, neither software science's E metric cyclomatic complexity not source lines of code appears to relate convincingly better with effort than the others. Author

N87-24901*# Maryland Univ., College Park. Dept. of Computer Science.
MONITORING SOFTWARE DEVELOPMENT THROUGH DYNAMIC VARIABLES
Carl W. Doerflinger and Victor R. Basili *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 26 p Previously announced in IAA as A85-49049 (For primary document see N87-24895 18-61)
Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

Research conducted by the Software Engineering Laboratory (SEL) on the use of dynamic variables as a tool to monitor software development is described. Project independent measures which may be used in a management tool for monitoring software development are identified. Several FORTRAN projects with similar profiles are examined. The staff was experienced in developing these types of projects. The projects developed serve similar functions. Because these projects are similar some underlying relationships exist that are invariant between projects. These relationships, once well defined, may be used to compare the development of different projects to determine whether they are evolving the same way previous projects in this environment evolved. Author

N87-24902*# Maryland Univ., College Park.
SOFTWARE ERRORS AND COMPLEXITY: AN EMPIRICAL INVESTIGATION
Victor R. Basili and Berry T. Perricone *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 24 p Previously announced in IAA as A83-32358 (For primary document see N87-24895 18-61)
(Grant NsG5-123)
(TR-1195) Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

The distributions and relationships derived from the change data collected during the development of a medium scale satellite software project show that meaningful results can be obtained which allow an insight into software traits and the environment in which it is developed. Modified and new modules were shown to behave similarly. An abstract classification scheme for errors which allows a better understanding of the overall traits of a software project is also shown. Finally, various size and complexity metrics are examined with respect to errors detected within the software yielding some interesting results. Author

N87-24903*# Maryland Univ., College Park.
A METHODOLOGY FOR COLLECTING VALID SOFTWARE ENGINEERING DATA
Victor R. Basili and David M. Weiss (Naval Research Lab., Washington, D. C.) *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 23 p (For primary document see N87-24895 18-61)
(Grant NsG5-123)
(TR-1235) Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

An effective data collection method for evaluating software development methodologies and for studying the software development process is described. The method uses goal-directed data collection to evaluate methodologies with respect to the claims made for them. Such claims are used as a basis for defining the goals of the data collection, establishing a list of questions of interest to be answered by data analysis, defining a set of data categorization schemes, and designing a data collection form. The data to be collected are based on the changes made to the software during development, and are obtained when the changes are made. To insure accuracy of the data, validation is performed concurrently with software development and data collection. Validation is based on interviews with those people supplying the data. Results from using the methodology show that data validation is a necessary part of change data collection. Without it, as much as 50% of the data may be erroneous. Feasibility of the data collection methodology was demonstrated by applying it to five different projects in two different environments. The application showed that the methodology was both feasible and useful. Author

N87-24904*# Maryland Univ., College Park. Dept. of Computer Science.
DATA COLLECTION AND EVALUATION FOR EXPERIMENTAL COMPUTER SCIENCE RESEARCH
Marvin V. Zelkowitz *In* NASA Goddard Space Flight Center Collected Software Engineering Papers, Volume 2 Nov. 1983 20 p (For primary document see N87-24895 18-61)
Avail: NTIS HC A10/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

The Software Engineering Laboratory was monitoring software development at NASA Goddard Space Flight Center since 1976. The data collection activities of the Laboratory and some of the difficulties of obtaining reliable data are described. In addition, the application of this data collection process to a current prototyping experiment is reviewed. Author

N87-24905*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COLLECTED SOFTWARE ENGINEERING PAPERS, VOLUME 4
Nov. 1986 107 p
(NASA-TM-89368; SEL-86-004-Vol-4; NAS 1.15:89368)
Copyright Avail: NTIS HC A06/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

The Software Engineering Laboratory (SEL) organization, operation, and research activities are summarized. The results of specific projects in the areas of technology evaluation and software measurement are described. For individual titles, see N87-24906 through N87-24910.

N87-24906*# Computer Sciences Corp., Silver Spring, Md.
AN APPROACH FOR ASSESSING SOFTWARE PROTOTYPES
V. E. Church, D. N. Card, W. W. Agresti, and Q. L. Jordan *In* NASA. Goddard Space Flight Center, Collected Software Engineering Papers, Volume 4 Nov. 1986 12 p (For primary

document see N87-24905 18-61)
Avail: NTIS HC A06/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

A procedure for evaluating a software prototype is presented. The need to assess the prototype itself arises from the use of prototyping to demonstrate the feasibility of a design or development stategy. The assessment procedure can also be of use in deciding whether to evolve a prototype into a complete system. The procedure consists of identifying evaluations criteria, defining alterative design approaches, and ranking the alternatives according to the criteria. Author

N87-24907*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TOWARDS A GENERAL OBJECT-ORIENTED SOFTWARE DEVELOPMENT METHODOLOGY
Ed Seidewitz and Mike Stark *In its* Collected Software Engineering Papers, Volume 4 Nov. 1986 14 p (For primary document see N87-24905 18-61)
Avail: NTIS HC A06/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

Object diagrams were used to design a 5000 statement team training exercise and to design the entire dynamics simulator. The object diagrams are also being used to design another 50,000 statement Ada system and a personal computer based system that will be written in Modula II. The design methodology evolves out of these experiences as well as the limitations of other methods that were studied. Object diagrams, abstraction analysis, and associated principles provide a unified framework which encompasses concepts from Yourdin, Booch, and Cherry. This general object-oriented approach handles high level system design, possibly with concurrency, through object-oriented decomposition down to a completely functional level. How object-oriented concepts can be used in other phases of the software life-cycle, such as specification and testing is being studied concurrently. Author

N87-24908*# Computer Sciences Corp., Silver Spring, Md.
AN EMPIRICAL STUDY OF SOFTWARE DESIGN PRACTICES
David N. Card, Victor E. Church, and William W. Agresti *In* NASA. Goddard Space Flight Center, Collected Software Engineering Papers, Volume 4 Nov. 1986 8 p (For primary document see N87-24905 18-61)
(IEEE-8405411) Avail: NTIS HC A06/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

Software engineers have developed a large body of software design theory and folklore, much of which was never validated. The results of an empirical study of software design practices in one specific environment are presented. The practices examined affect module size, module strength, data coupling, descendant span, unreferenced variables, and software reuse. Measures characteristic of these practices were extracted from 887 FORTRAN modules developed for five flight dynamics software projects monitored by the Software Engineering Laboratory (SEL). The relationship of these measures to cost and fault rate was analyzed using a contingency table procedure. The results show that some recommended design practices, despite their intuitive appeal, are ineffective in this environment, whereas others are very effective. Author

N87-24909*# Computer Sciences Corp., Silver Spring, Md.
DESIGNING WITH ADA FOR SATELLITE SIMULATION: A CASE STUDY
William W. Agresti, Victor E. Church, David N. Card, and P. L. Lo *In* NASA. Goddard Space Flight Center, Collected Software Engineering Papers, Volume 4 Nov. 1986 14 p (For primary document see N87-24905 18-61)
Avail: NTIS HC A06/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

A FORTRAN-operated and an Ada-oriented design for the same system are compared to learn whether an essentially different design was produced using Ada. The designs were produced by an experiment that involves the parallel development of software for a spacecraft dynamics simulator. Design differences are identified in the use of abstractions, system structure, and simulator operations. Although the designs were significantly different, this result may be influenced by some special characteristics discussed. Author

N87-24910*# Maryland Univ., College Park. Dept. of Computer Science.
A STUDY OF FAULT PREDICTION AND RELIABILITY ASSESSMENT IN THE SEL ENVIRONMENT
Victor R. Basili and Debabrata Patnaik *In* NASA. Goddard Space Flight Center, Collected Software Engineering Papers, Volume 4 Nov. 1986 25 p (For primary document see N87-24905 18-61)
(Grant NsG-5123)
(TR-1699) Avail: NTIS HC A06/MF A01; single copies available from NASA/GSFC, Code 552, Greenbelt, Md. 20771 CSCL 09B

An empirical study on estimation and prediction of faults, prediction of fault detection and correction effort, and reliability assessment in the Software Engineering Laboratory environment (SEL) is presented. Fault estimation using empirical relationships and fault prediction using curve fitting method are investigated. Relationships between debugging efforts (fault detection and correction effort) in different test phases are provided, in order to make an early estimate of future debugging effort. This study concludes with the fault analysis, application of a reliability model, and analysis of a normalized metric for reliability assessment and reliability monitoring during development of software. Author

N87-24911*# Columbia Univ., New York. Psychophysics Lab.
MULTIPLE PATHS IN COMPLEX TASKS
Eugene Galanter, Thomas Wiegand, and Gloria Mark 15 Jul. 1987 39 p
(Grant NAGw-860)
(NASA-CR-180392; NAS 1.26:180392; PPL-87/4) Avail: NTIS HC A03/MF A01 CSCL 09B

The relationship between utility judgments of subtask paths and the utility of the task as a whole was examined. The convergent validation procedure is based on the assumption that measurements of the same quantity done with different methods should covary. The utility measures of the subtasks were obtained during the performance of an aircraft flight controller navigation task. Analyses helped decide among various models of subtask utility combination, whether the utility ratings of subtask paths predict the whole tasks utility rating, and indirectly, whether judgmental models need to include the equivalent of cognitive noise. B.G.

N87-24912*# Washington Univ., St. Louis, Mo. Center for Biotechnology.
BIOASPEN: SYSTEM FOR TECHNOLOGY DEVELOPMENT Interim Report
Feb. 1986 107 p Prepared for JPL
(Contract JPL-956965)
(NASA-CR-181086; JPL-9950-1303; NAS 1.26:181086) Avail: NTIS HC A06/MF A01 CSCL 09B

The public version of ASPEN was installed in the VAX 11/750 computer. To examine the idea of BIOASPEN, a test example (the manufacture of acetone, butanol, and ethanol through a biological route) was chosen for simulation. Previous reports on the BIOASPEN project revealed the limitations of ASPEN in modeling this process. To overcome some of the difficulties, modules were written for the acid and enzyme hydrolyzers, the fermentor, and a sterilizer. Information required for these modules was obtained from the literature whenever possible. Additional support modules necessary for interfacing with ASPEN were also written. Some of ASPEN subroutines were themselves altered in order to ensure the correct running of the simulation program. After testing of these additions and charges was completed, the Acetone-Butanol-Ethanol (ABE) process was simulated. A release of ASPEN (which contained the Economic Subsystem) was

obtained and installed. This subsection was tested and numerous charges were made in the FORTRAN code. Capital investment and operating cost studies were performed on the ABE process. Some alternatives in certain steps of the ABE simulation were investigated in order to elucidate their effects on the overall economics of the process. Author

N87-24913# Oak Ridge National Lab., Tenn.
PARALLEL SOLUTION OF TRIANGULAR SYSTEMS ON DISTRIBUTED-MEMORY MULTIPROCESSORS
M. T. Heath and C. H. Romine Mar. 1987 45 p
(Contract DE-AC05-84OR-21400)
(DE87-008558; ORNL/TM-10384) Avail: NTIS HC A03/MF A01

Several parallel algorithms are presented for solving triangular systems of linear equations on distributed-memory multiprocessors. New wavefront algorithms are developed for both row-oriented and column-oriented matrix storage. Performance of the new algorithms and several previously proposed algorithms is analyzed theoretically and illustrated empirically using implementations on commercially available hypercube multiprocessors. DOE

N87-24914# Argonne National Lab., Ill.
AN ALGEBRAIC THEORY OF PROGRAM SPECIFICATION AND CORRECTNESS USING SYMMETRY OPERATIONS
J. R. Gabriel Mar. 1987 21 p
(Contract W-31-109-eng-38)
(DE87-009226; ANL-87-10) Avail: NTIS HC A02/MF A01

This report applies some methods from the theory of group representation to the questions of program specification and knowledge about programs. The theory is that of a program as a transformation on a state space, and operators commuting with that transformation being symmetries of the program, means of specifying properties, and generators of program invariants. Because a program can simulate a system in the real world, there is a corresponding model of engineered artifacts, that is, manmade objects having a theory for their design. DOE

N87-24915# Los Alamos National Lab., N. Mex.
MAX3D: A THREE-DIMENSIONAL FINITE-ELEMENT COMPUTER PROGRAM FOR SOLVING MAXWELL'S EQUATIONS
W. A. Cook Apr. 1987 17 p
(Contract W-7405-eng-36)
(DE87-009483; LA-10973-MS) Avail: NTIS HC A02/MF A01

MAX3D is a three-dimensional computer program for solving Maxwell's electromagnetic field equations. The equations solved by this code neglect the displacement current and charge density. This report documents Maxwell's electromagnetic field equations, the simplifying assumptions, and the boundary conditions. The field equations are then written in terms of a scalar potential and a vector potential. A variational principle, which is presented in terms of these potentials, is equivalent to Maxwell's theory and to the boundary conditions. Finite-element approximations applied to the variational principle give a set of linear algebraic equations that can be solved to approximate the electric and magnetic fields. DOE

N87-24916 Paris-Sud Univ., Orsay (France).
COMPUTER ASSISTED DESIGN APPLIED TO ROUTING IN VLSI INTEGRATED CIRCUITS Ph.D. Thesis [LA CONCEPTION ASSISTEE PAR ORDINATEUR APPLIQUEE AU ROUTAGE DANS LES CIRCUITS INTEGRES VLSI]
Ag Rhissa Anasser 1985 141 p In FRENCH; ENGLISH summary
(ETN-87-99564) Avail: Issuing Activity

Algorithms for VLSI channel routing with two levels of technology are presented. The concepts of operational research are used. One algorithm is based on graph optimization and the other on stochastic optimization by simulated annealing. Applications of simulated annealing to the physical design of systems are also described. The methods reduce the number of tracks necessary for the interconnections. ESA

N87-24917# AEG-Telefunken, Ulm (West Germany). Entwicklungszentrum Integrierte Schaltungen.
GATE ARRAY COMPONENTS Final Report, Jun. 1984
Guenther Bergmann, Hans-Joachim Golberg, Martin Gerbershagen, Sorin Huss, Stefan Renz, Dieter Kohlert, Heinz Richter, Hans-Joachim Rothermel, Irmtraud Rugen, Claudia Schroeck-Pauli et al. Bonn, West Germany BMFT Dec. 1986 228 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-104; ISSN-0340-7608; ETN-87-99698) Avail: NTIS HC A11/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 40

Hardware and software components for gate arrays were realized. Three transistor arrays for LF applications with circuit library; a 2000 components array applying a fast bipolar technology; two ECL arrays applying a fast bipolar technology with macro-library; and a CMOS array with 1600 gate functions and with macrolibrary were developed. Software tools, allowing a standardized gate array development method, are discussed: interactive design of CMOS gate arrays and back-annotation; back-annotation for transistor arrays; automatic placement and routing for gate arrays in single and double layer metallization and methods for back-annotation; and verification of logic design and timing simulation. ESA

N87-24918# Telefunken Electronic G.m.b.H., Heilbronn (West Germany).
CAD TOOLS FOR THE DEVELOPMENT OF HIGHLY COMPLEX MOS INTEGRATED CIRCUITS Final Report, Jul. 1985
Uwe Jaeger, Wilfried Jud, Christian Krueger, Rainer Praxmarer, and Karl-Heinz Haerberlein Bonn, West Germany BMFT Dec. 1986 138 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-114; ISSN-0340-7608; ETN-87-99701) Avail: NTIS HC A07/MF A01; Fachinformationszuntrum, Karlsruhe, West Germany DM 29

Computer aided design (CAD) tools for the development of customer-oriented IC's were realized. A high level simulator which can be adapted to present CAD systems; CAD programs for an automated layout design and control; a functional placement and routing system, integrated in the global CAD system for the automation of the macrodesign and the cabling; and a digital simulator and test pattern generator are described. ESA

N87-24919# Army Electronic Proving Ground, Fort Huachuca, Ariz.
COMPUTER HARDWARE/SOFTWARE MONITOR Final Report
K. E. VanKarsen Sep. 1986 77 p
(AD-A179777; AD-E900683) Avail: NTIS HC A05/MF A01
CSCL 09B

Previous investigations established methods for evaluating software or systems containing multiple interactive processors. These investigations resulted in the development of a hybrid monitor concept: the integration of both hardware and software monitor capabilities into a central monitor system. This investigation resulted in revision of the specification documents and continued design and implementation of the prototype hybrid monitor. The prototype was completed sufficiently to validate the HM concept and demonstrate the feasibility of collecting various measures of performance. GRA

N87-24920# Naval Research Lab., Washington, D. C.
A METHOD FOR VALIDATING MULTIDIMENSIONAL FAST FOURIER TRANSFORM (FFT) ALGORITHMS Final Report, 1 Oct. 1985 - 30 Sep. 1986
John M. Bergin 8 Apr. 1987 18 p
(AD-A179998; NRL-9042) Avail: NTIS HC A02/MF A01
CSCL 12A

A method is described for validating fast Fourier transforms (FFTs) based on the use of simple input functions whose discrete Fourier transforms can be evaluated in closed form. Explicit analytical results are developed for one dimensional and two dimensional discrete Fourier transforms. The analytical results are easily generalized to higher dimensions. The results offer a means

for validating the FFT algorithm in one, two, or higher dimensional settings. The general motivation for the work comes from the need to validate the FFT algorithm when it newly implemented on a computer or when new techniques or devices are added to a computer facility to evaluate discrete Fourier transforms. GRA

N87-24921# Honeywell, Inc., Edina, Minn. Defense Systems Div.
USER INSTRUCTIONS FOR THE EPIC-2 CODE Final Report, Oct. 1983 - May 1986
G. R. Johnson and R. A. Stryk Sep. 1986 69 p
(Contract F08635-83-C-0506)
(AD-A173975; AFATL-TR-86-51; Rept-7-86-6) Avail: NTIS HC A04/MF A01 CSCL 09B

This report provides user instructions for the I986 version of the EPIC-2 code. The new capabilities in this code are a NABOR option for variable nodal connectivity, crushable materials, one dimensional geometry, plane stress geometry, quad elements, eroding interfaces, expanded postprocessing and a target add option. Instructions are included for the Preprocessor, the Main Routine and the Postprocessor. An example problem is also provided. Author (GRA)

N87-24922*# Texas A&M Univ., College Station.
A CASCADED CODING SCHEME FOR ERROR CONTROL AND ITS PERFORMANCE ANALYSIS
Shu Lin, Tadao Kasami, Tohru Fujiwara, and Toyoo Takata (Osaka Univ., Toyonaka, Japan) [1986] 23 p
(Grant NAG5-778)
(NASA-CR-181124; NAS 1.26:181124) Avail: NTIS HC A02/MF A01 CSCL 09B

A coding scheme is investigated for error control in data communication systems. The scheme is obtained by cascading two error correcting codes, called the inner and outer codes. The error performance of the scheme is analyzed for a binary symmetric channel with bit error rate epsilon $<1/2$. It is shown that if the inner and outer codes are chosen properly, extremely high reliability can be attained even for a high channel bit error rate. Various specific example schemes with inner codes ranging form high rates to very low rates and Reed-Solomon codes as inner codes are considered, and their error probabilities are evaluated. They all provide extremely high reliability even for very high bit error rates. Several example schemes are being considered by NASA for satellite and spacecraft down link error control. Author

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N87-24923# California Univ., Berkeley. Dept. of Computer Sciences.
A TRACE-DRIVEN SIMULATION STUDY OF DYNAMIC LOAD BALANCING Technical Report, 7 Aug. 1984 - 6 Aug. 1987
Songnian Zhou Jan. 1987 30 p
(Contract N00039-84-C-0089; ARPA Order 4871)
(AD-A179323) Avail: NTIS HC A03/MF A01 CSCL 09B

A trace-driven simulation study of dynamic load balancing in homogeneous distributed systems supporting broadcasting is presented. We use information about job CPU and I/O demands collected from a production system as input to a simulation model that includes a representative CPU scheduling policy and considers the message exchange and job transfer costs explicitly. Seven load balanced algorithms are simulated and their performances compared. We find that load balancing is capable of significantly reducing the mean and standard deviation of job response times, especially under heavy system load, and for jobs with high resource demands. The performances of all hosts, even those originally with light loads, are generally improved by load balancing. The reduction of the mean response time increases with the number of hosts, but levels off at around 30 hosts. Algorithms based on periodic or non-periodic load information exchange provide similar performance, and, among the periodic policies, the algorithms that use a distinguished agent to collect and distribute load information cut down the overhead and scale better. GRA

N87-24924*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STATUS AND PROJECTIONS OF THE NAS PROGRAM
Frank R. Bailey Jul. 1986 18 p
(NASA-TM-88339; A-86325; NAS 1.15:88339) Avail: NTIS HC A02/MF A01 CSCL 09B

NASA's Numerical Aerodynamic Simulation (NAS) Program has completed development of the initial operating configuration of the NAS Processing System Network (NPSN). This is the first milestone in the continuing and pathfinding effort to provide state-of-the-art supercomputing for aeronautics research and development. The NPSN, available to a nation-wide community of remote users, provides a uniform UNIX environment over a network of host computers ranging from the Cray-2 supercomputer to advanced scientific workstations. This system, coupled with a vendor-independent base of common user interface and network software, presents a new paradigm for supercomputing environments. Background leading to the NAS program, its programmatic goals and strategies, technical goals and objectives, and the development activities leading to the current NPSN configuration are presented. Program status, near-term plans, and plans for the next major milestone, the extended operating configuration, are also discussed. Author

63 CYBERNETICS

Includes feedback and control threory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N87-24925*# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.
ROBUST TIME AND FREQUENCY DOMAIN ESTIMATION METHODS IN ADAPTIVE CONTROL
Richard Orville Lamaire Jun. 1987 339 p
(Grant NAG2-297)
(NASA-CR-181074; NAS 1.26:181074; LIDS-TH-1674) Avail: NTIS HC A15/MF A01 CSCL 09B

A robust identification method was developed for use in an adaptive control system. The type of estimator is called the robust estimator, since it is robust to the effects of both unmodeled dynamics and an unmeasurable disturbance. The development of the robust estimator was motivated by a need to provide guarantees in the identification part of an adaptive controller. To enable the design of a robust control system, a nominal model as well as a frequency-domain bounding function on the modeling uncertainty associated with this nominal model must be provided. Two estimation methods are presented for finding parameter estimates, and, hence, a nominal model. One of these methods is based on the well developed field of time-domain parameter estimation. In a second method of finding parameter estimates, a type of weighted least-squares fitting to a frequency-domain estimated model is used. The frequency-domain estimator is shown to perform better, in general, than the time-domain parameter estimator. In addition, a methodology for finding a frequency-domain bounding function on the disturbance is used to compute a frequency-domain bounding function on the additive modeling error due to the effects of the disturbance and the use of finite-length data. The performance of the robust estimator in both open-loop and closed-loop situations is examined through the use of simulations. Author

N87-24926# European Space Agency, Paris (France).
CONTRIBUTION TO THE STUDY OF PERTURBATIONAL STABILIZATION
O. Vidal Jan. 1987 202 p Transl. into ENGLISH of " Contribution a l'Etude de la Stabilisation des Systemes par Perturbations (Chatillon, France), Report ONERA-NT-1984-1, 1984 Original

language document was announced at N85-20781
(ESA-TT-905; ONERA-NT-1984-1; ETN-87-99850) Avail: NTIS HC A10/MF A01

Stabilizing systems by introducing perturbations of their parameters without modifying variables or applying feedback is studied. Periodic, almost periodic, and random perturbation are analyzed. Stabilization of continuous linear systems and of continuous and discrete quadratic and bilinear systems is considered, since in these cases perturbational stabilization yields theoretical and experimental results that are effective. Thus, by introducing zero-mean oscillations into the nonlinear part of the system, weakly nonlinear systems can be stabilized. The averaging method is used. ESA

N87-24927 Oklahoma State Univ., Stillwater.
CONTROLLER DESIGN FOR NONLINEAR SYSTEMS BASED ON SIMULTANEOUS STABILIZATION THEORY AND DESCRIBING FUNCTION MODELS Ph.D. Thesis
Amir Nassirharand 1986 200 p
Avail: Univ. Microfilms Order No. DA8701047

A systematic and algebraic linear design procedure was developed for use with feedback control systems which have highly nonlinear, single-input single-output, time-invariant, deterministic, and continuous time plants. The procedure is composed of six primary steps: (1) specification of a set of performance measures for the closed-loop system either in the time or frequency domain, and identification of the linear reference model of an open-loop system whose performance is similar to that required from the closed-loop system; (2) characteristics of the input/output behavior of the nonlinear plant; (3) identification of two linear systems whose input/output behavior approximates that of the two quasilinear models of the plant whose gain characteristics bound those of all others in the class; (4) parameterization of the class of all controllers that simultaneously stabilize the two identified linear plants; (5) search of the class of all stabilizing controllers for the near-optimum linear controller; and (6) validation of the design via a digital simulation. Application of the procedure to an example problem revealed that the identified dual-range linear controller achieved a closed-loop system whose dynamic behavior was less sensitive to the amplitude level of the input command than that of conventional linear system methods. Also the system's behavior satisfied a set of user-defined performance measures in a near-optimum fashion. Dissert. Abstr.

N87-24945*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON COMBAT AIRCRAFT
Lawrence M. Ott, Kathy Abbot, Alfred Kleider, D. Moon, and John Retelle (Defense Advanced Research Projects Agency, Arlington, Va.) *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 4 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01 CSCL 09B

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N87-24928# Clarkson Univ., Potsdam, N.Y. Dept. of Mathematics and Computer Science.
NONLINEAR WAVES Final Report
Mark J. Ablowitz and Athanassios S. Fokas 31 Jan. 1987 227 p
(Contract N00014-86-K-0603)
(AD-A179077) Avail: NTIS HC A11/MF A01 CSCL 12A

The central theme involved in this work is the continuing study of certain fundamental features associated with the nonlinear wave propagation arising in and motivated by physical problems. The usefulness of the work is attested to by the varied applications, and wide areas of interest in physics, engineering and mathematics. The work accomplished in our overall program of study involves wave propagation in a number of areas including fluid mechanics, plasma physics, theoretical physics, statistical mechanics, nonlinear optics, multidimensional solitons, multidimensional inverse problems, Painleve equations, direct linearizations of certain nonlinear wave equations, DBAR problems, Riemann-Hilbert boundary value problems, algebraic methods and symmetry analysis of multidimensional systems, differential geometry, etc. Of practical interest to the Navy is the recent discovery that many of the equations describing ship hydrodynamics in channels of finite depth obey nonlinear equations which have been studied extensively by our group. Similar statements are also true for many important equations arising in the study of digital communication via solitons. GRA

N87-24929# Maryland Univ., College Park. Inst. for Physical Science and Technology.
THE h-p VERSION OF THE FINITE ELEMENT METHOD FOR DOMAINS WITH THE CURVED BOUNDARIES Final Report
I. Babuska and B. Guo Dec. 1986 56 p
(Contract N00014-85-K-0169; Grants NSF DMS-85-16191; AF-AFOSR-0277-80)
(AD-A178388; BN-1057) Avail: NTIS HC A04/MF A01 CSCL 12A

The paper analyzes the convergence of the h-p version of the finite element method for elliptic problems on curved domains. It proves, that when the boundary of the domain is piecewise analytic, boundary conditions are piecewise analytic and the sides of the elements are analytic, the n-p version has exponential rate of convergence. Numerical computations are included. GRA

N87-24930*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN EXPONENTIAL FINITE DIFFERENCE TECHNIQUE FOR SOLVING PARTIAL DIFFERENTIAL EQUATIONS M.S. Thesis - Toledo Univ., Ohio
Robert F. Handschuh (Army Aviation Research and Development Command, Cleveland, Ohio.) Jun. 1987 135 p
(NASA-TM-89874; E-3544; NAS 1.15:89874; AVSCOM-TR-87-C-19) Avail: NTIS HC A07/MF A01 CSCL 12A

An exponential finite difference algorithm, as first presented by Bhattacharya for one-dimensianal steady-state, heat conduction in Cartesian coordinates, has been extended. The finite difference algorithm developed was used to solve the diffusion equation in one-dimensional cylindrical coordinates and applied to two- and three-dimensional problems in Cartesian coordinates. The method was also used to solve nonlinear partial differential equations in one (Burger's equation) and two (Boundary Layer equations) dimensional Cartesian coordinates. Predicted results were compared to exact solutions where available, or to results obtained by other numerical methods. It was found that the exponential finite difference method produced results that were more accurate than those obtained by other numerical methods, especially during the initial transient portion of the solution. Other applications made using the exponential finite difference technique included unsteady one-dimensional heat transfer with temperature varying thermal conductivity and the development of the temperature field in a laminar Couette flow. Author

N87-24931# Sandia National Labs., Albuquerque, N. Mex.
IMPROVING THE PERFORMANCE OF A CODE FOR SOLVING STIFF SYSTEMS OF ODEs
D. E. Salane Nov. 1986 26 p
(Contract DE-AC04-76DP-00789)
(DE87-009379; SAND-86-2159) Avail: NTIS HC A03/MF A01

The performance of LSODE, a widely used code for solving stiff systems of ordinary differential equations, has been improved by using strategies that reduce the need to evaluate Jacobians. Two such strategies are examined, and each has been implemented in LSODE. Numerical experiments show that the modified versions of LSODE outperform a standard library version on a variety of difficult stiff test problems. DOE

N87-24932# International Centre for Theoretical Physics, Trieste (Italy).
ON THE GROUP-THEORETIC APPROACH TO THE CONSERVATION LAWS OF KP EQUATION IN LAGRANGIAN AND HAMILTONIAN FORMALISM
A. RoyChowdhury and S. Roy Jun. 1986 12 p
(DE87-701785; IC-86/113) Avail: NTIS (US Sales Only) HC A02/MF A01

The conservation laws for some non-linear system is determined through the use of Noether's theorem, Lagrangian theory and Lie symmetry. Though in principle for each generator of Lie symmetry there is a conserved vector yet due to the Lie algebra generated by these generators some of these vectors become linearly dependent. So we have searched for the minimum number of independent conserved vector and have called it a basis of the conservation laws. Such bases of conservation laws are obtained in the case of the KP equation in three dimensions. Next it is shown how the same analysis can be performed in a compact manner through the use of the Hamiltonian formalism. The only difference is that the later methodology yields the time component of the conserved vector and their linear dependence. DOE

N87-24933*# Hawaii Univ., Honolulu. Dept. of Electrical Engineering.
PERFORMANCE ANALYSIS OF A HYBRID ARQ ERROR CONTROL SCHEME FOR NEAR EARTH SATELLITE COMMUNICATIONS
Shu Lin 1 Aug. 1987 47 p
(Grant NAG5-931)
(NASA-CR-181120; NAS 1.26:181120; TR-1) Avail: NTIS HC A03/MF A01 CSCL 12A

A robust error control coding scheme is presented. The scheme is a cascaded forward error correction (FEC) scheme supported by parity retransmissions for further error correction in the erroneous data words. The error performance and throughput efficiency of the scheme are analyzed. Two specific schemes are proposed for NASA near earth satellite communications. It is shown that both schemes provide high reliability and throughput efficiency even for high channel bit error rates in the range of .002. The schemes are suitable for high data rate file transfer. Author

N87-24934# Aeronautical Research Labs., Melbourne (Australia).
AN IMPROVED COMPUTATIONAL PROCEDURE FOR THE UNSTEADY DOUBLET LATTICE METHOD
W. Waldman Aug. 1986 61 p
(ARL-STRUC-R-423; AR-004-497) Copyright Avail: NTIS HC A04/MF A01

A further modification and enhancement of the doublet lattice computational procedure in use at Aeronautical Research Laboratory (ARL) is described. The theoretical basis for the procedures used to integrate the unsteady Kernel function is covered in detail. A number of cases involving nonplanar and nonparallel lifting surface combinations are studied, and the results are compared with those of other workers. These show generally good agreement, although the predictions of the magnitudes of the forces acting on a tipstore and an underwing store do not compare as favorably. The present method was implemented at ARL into the FORTRAN 77 program called DOULAT. Author

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N87-24935# Missouri Univ., Columbia. Dept. of Statistics.
APPROXIMATION FOR BAYESIAN ABILITY ESTIMATION Technical Report, 1 Jan. 1985 - 31 Dec. 1986
Robert K. Tsutakawa and Michael J. Soltys 18 Feb. 1987 35 p
(Contract N00014-85-K-0113; RR0-4204)
(AD-A179103; TR-134) Avail: NTIS HC A03/MF A01 CSCL 12A

An approximation is proposed for the posterior mean and standard deviation of the ability parameter in an item response model. The procedure assumes that approximations to the posterior mean and covariance matrix of item parameters are available. It is based on the posterior mean of a Taylor series approximation to the posterior mean conditional on the item parameters. The method is illustrated for the two-parameter logistic model using data from an ACT math test with 39 items. A numerical comparison with the empirical Bayes method shows that the point estimates are very similar but the standard deviations under empirical Bayes are about two percent smaller than those under Bayes. The effect of sample size is demonstrated by illustrating the increase in the standard deviations for a smaller data set. Author (GRA)

N87-24936# Northrop Research and Technology Center, Palos Verdes Peninsula, Calif.
INVESTIGATION OF CLASSIFIER ALGORITHMS (CAPIR) Final Report
1 Feb. 1987 64 p
(Contract DAAL02-85-C-0151)
(AD-A178410) Avail: NTIS HC A04/MF A01 CSCL 19E

The objective of this project is to develop and study an optimal classifier so that future ATR designers can concentrate on feature extraction. The specific tasks are: (1) Perform feature extraction and analysis on ERIM-supplied segmentor outputs; (2) Develop probability density estimates and figure-of-merit computations for kernel-based classifier; (3) Develop estimates for confidence in the probability density estimates; and (4) Evaluate and demonstrate classifier using above items. This report is divided into nine sections. Section 2 details the feature extraction task and includes information about the exchange of data with ERIM. Section 3 describes the classifiers used as well as the window-width optimization problem in producing density estimates with the kernel-based classifier. Section 4 describes the confidence measures used to attack task C. Section 5 presents the results of a study on the development set of images, while Section 6 reports results for the characterization set of images and comparisons of these results to the development set results. Section 7 gives the results of the window-width optimization study while Section 8 presents confidence measure experiments. Finally, Section 9 gives the conclusions of this study. GRA

N87-24937*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
VALIDATION OF THE SURE PROGRAM, PHASE 1
Kelly J. Dotson May 1987 49 p
(NASA-TM-89123; NAS 1.15:89123) Avail: NTIS HC A03/MF A01 CSCL 09B

Presented are the results of the first phase in the validation of the SURE (Semi-Markov Unreliability Range Evaluator) program. The SURE program gives lower and upper bounds on the death-state probabilities of a semi-Markov model. With these bounds, the reliability of a semi-Markov model of a fault-tolerant computer system can be analyzed. For the first phase in the validation, fifteen semi-Markov models were solved analytically for the exact death-state probabilities and these solutions compared to the corresponding bounds given by SURE. In every case, the SURE bounds covered the exact solution. The bounds, however, had a tendency to separate in cases where the recovery rate was slow or the fault arrival rate was fast. Author

N87-24938# Technische Univ., Berlin (West Germany). Inst. fuer Luft- und Raumfahrt.
STATISTICAL CONSIDERATIONS ON THE INSTITUTE OF AERONAUTICS AND ASTRONAUTICS AND THE FIELD OF SPACE ENGINEERING [STATISCHE BETRACHTUNGEN UEBER DAS INSTITUT FUER LUFT- UND RAUMFAHRT UND DAS FACHGEBIET RAUMFAHRTTECHNIK]
H. H. Koelle 1986 38 p In GERMAN
(ILR-Mitt-162; ETN-87-99671) Avail: NTIS HC A03/MF A01

The development trends at the Institute of Aeronautics and Astronautics and at Universities are depicted. ESA

N87-24939*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
COMPARISON OF TWO NUMERICAL TECHNIQUES FOR AERODYNAMIC MODEL IDENTIFICATION
M. H. Verhaegen Jun. 1987 11 p
(NASA-TM-89467; A-87244; NAS 1.15:89467) Avail: NTIS HC A02/MF A01 CSCL 12A

An algorithm, called the Minimal Residual QR algorithm, is presented to solve subset regression problems. It is shown that this scheme can be used as a numerically reliable implementation of the stepwise regression technique, which is widely used to identify an aerodynamic model from flight test data. This capability as well as the numerical superiority of this scheme over the stepwise regression technique is demonstrated in an experimental simulation study. Author

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N87-24940# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.
ADVANCED COMPUTER AIDS IN THE PLANNING AND EXECUTION OF AIR WARFARE AND GROUND STRIKE OPERATIONS
Loughton, England Feb. 1987 140 p In ENGLISH and FRENCH Meeting held in Kongsberg, Norway, 12-16 May 1986 Original contains color illustrations
(AGARD-CP-404; ISBN-92-835-0410-0) Copyright Avail: NTIS HC A07/MF A01

The pace and complexity of modern air warfare have reached the point where advanced computer aids are essential to assist the aircrew and the commander on the ground. Computers are now used extensively in the operation and control of specific equipment, such as advanced weapon systems, surveillance radars, electronic warfare and communications systems. However, there are still many areas which rely heavily on human decision making. The increasing use of Artificial Intelligence (AI) techniques, including Intelligent Knowledge Based Systems (IKBS) and Expert Systems will at one extreme allow decision making to be increasingly automated or controlled by non-expert personnel, and at the other extreme greatly extend the capabilities of military commanders. The successful application of computers should provide improved effectiveness, flexibility, and reliability resulting in a saving of resources and personnel. For individual titles, see N87-24941 through N87-24955.

N87-24941# Software Sciences Ltd., Farnborough (England). Electronic Warfare Dept.
THE USE OF KNOWLEDGE BASED SYSTEMS TECHNIQUES IN ESM PROCESSING
J. H. Palfreyman *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 8 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

The Electronic Support Measures (ESM) System attempts to detect, analyze, and classify sources of radio and radar emissions in the environment. The ESM system provides valuable emitter classification information to the host platform's Command and Control System or associated Electronic Countermeasures (ECM) equipment. However, the current generation of Automatic ESM systems often produce ambiguous or incorrect emitter classifications in the adverse conditions of actual conflict. The application of Knowledge Based Systems techniques to ESM processing are described and the development and evaluation of a Knowledge Based ESM system model aimed specifically at improving the emitter classification capability of automatic ESM are outlined. Author

N87-24942# Rome Air Development Center, Griffiss AFB, N.Y.
DARPA's AirLand BATTLE MANAGEMENT PROGRAM AND USAF's TACTICAL EXPERT MISSION PLAnneR (TEMPLAR)
Peter F. H. Priest, II *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 6 p (For primary document see N87-24940 18-66)
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The Defense Advanced Research Projects Agency (DARPA) has a long history of supporting research in the areas of Artificial Intelligence (AI). The DARPA Strategic Computing Program is developing an AI technology base upon which several applications programs are being built including the AirLand Battle Management Program (ALBM). The ALBM program office is cofunding the U.S. Air Force's first major AI application: Rome Air Development Center's Tactical Expert Mission PLAnneR (TEMPLAR). The TEMPLAR program is an advanced development level effort that is building upon demonstrated systems at the exploratory development level as well as the Strategic Computing tech base. The TEMPLAR program and its links to the AirLand Battle Management and Strategic Computing Programs are described. Author

N87-24943# Rome Air Development Center, Griffiss AFB, N.Y.
KRS: A KNOWLEDGE-BASED MISSION PLANNER
Kevin M. Benner and Michael L. Hilton *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 7 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

The KRS program is a knowledge-based system for planning offensive-counter-air missions. The KRS aides human planners in preparing Air Tasking Orders and can either be used interactively as a plan verifier or autonomously as a plan generator. The KRS informs the user of any logical or doctrinal inconsistencies in a plan, and keeps track of resources and target status. Users can communicate with KRS via a natural language interface, pop-up menus, or a mouse pointing device. An overview of the KRS's capabilities, its knowledge representation schemes, how KRS verifies plans, and how plans are automatically generated, are presented. Author

N87-24944# Rome Air Development Center, Griffiss AFB, N.Y.
DECISION AID FOR THREAT PENETRATION ANALYSIS
Robert J. Kruchten *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 7 p (For primary document see N87-24940 18-66)
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A concept is described for a threat penetration aid. A proof-of-concept version of this aid was built at RADC on a Symbolics 3670 Lisp processing system. Route planning aids were created in the past to find a path through an area of ground threats. Unfortunately these aids tend to be limited by a narrow perspective of the threat environment and a mathematical approach that makes it difficult to add features. The intent of this effort was to create an aid that used heuristic reasoning to simplify the analysis and which had a more global perspective of the environment than the existing aids. Although there is recent work, most notably a TRW effort for in-flight replanning, that offers a more global perspective of the environment than existing aids, the approach used in unique. The concept presented offers great increases in speed over present route planning aids at a slight loss of precision. In addition, the aid goes beyond simple route optimization and can grow to directly assist in choosing tactics, electronic warfare applications, or saturation techniques. It also can quickly add, delete, modify, or move threats. It can take on these additional tasks by exploiting its speed advantage and data structure. The basic architecture of the aid, some of its limitations, its advantages, its growth potential, and finally some recommendations for

application development and further research are described.
Author

N87-24945*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON COMBAT AIRCRAFT **c63**
Lawrence M. Ott, Kathy Abbot, Alfred Kleider, D. Moon, and John Retelle (Defense Advanced Research Projects Agency, Arlington, Va.) *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 4 p (For primary document see N87-24940 18-66)
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As the threat becomes more sophisticated and weapon systems more complex to meet the threat, the need for machines to assist the pilot in the assessment of information becomes paramount. This is particularly true in real-time, high stress situations. The advent of artificial intelligence (AI) technology offers the opportunity to make quantum advances in the application of machine technology. However, if AI systems are to find their way into combat aircraft, they must meet certain criteria. The systems must be responsive, reliable, easy to use, flexible, and understandable. These criteria are compared with the current status used in a combat airborne application. Current AI systems deal with nonreal time applications and require significant user interaction. On the other hand, aircraft applications require real time, minimum human interaction systems. In order to fill the gap between where technology is now and where it must be for aircraft applications, considerable government research is ongoing in NASA, DARPA, and three services. The ongoing research is briefly summarized. Finally, recognizing that AI technology is in its embryonic stage, and the aircraft needs are very demanding, a number of issues arise. These issues are delineated and findings are provided where appropriate. Author

N87-24946# Rome Air Development Center, Griffiss AFB, N.Y.
ADVANCED SENSOR EXPLOITATION **c09**
Joseph Antonik and Leonard E. Converse, Jr. *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 5 p (For primary document see N87-24940 18-66)
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The Advanced Sensor Exploitation Testbed developed by the Rome Air Development Center for the purpose of evaluating and testing advanced techniques in the area of multisensor, multidiscipline correlation is described. The testbed consists of three subsystems: the scenario generation subsystem, the sensor simulation subsystem, and the correlation and exploitation algorithms. The scenario generation subsystem, referred to as Dynamic Ground Target Simulator, is a computer automated system for the development of ground truth. Ground truth is any activity that occurs in the battlefield in relation to movement or emission of opposing ground forces. The sensor simulation subsystem consists of generic moving target indicator, radio detection/location, radar detection/location and imaging type sensors that act as filters for the ground truth. The correlation and exploitation algorithms are resident within the Advanced Sensor Exploitation Element and provide such data as military unit identification, the identification and tracking of high priority/critical targets, threat alerts, and activity level indications. The Advanced Sensor Exploitation Testbed along with built-in evaluation routines allow for the development, test, and evaluation of automated correlation and identification algorithms in as a realistic environment as possible. Author

N87-24947# Naval Air Systems Command, Washington, D. C.
INTEGRATED MULTISENSOR TARGETING
Peter G. Krueger, Ernesto Benites, Douglas W. Cowan, W. Rodney Ditzler, and Alfred G. Sutton (Naval Weapons Center, China Lake, Calif.) *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 9 p (For primary document see N87-24940 18-66)
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The integrated multisensor targeting effort is a United States Navy Exploratory Development program directed at the development and demonstration of multisensor targeting algorithms for air-to-air application. The program for developing the capability is described. The current algorithm development is presented. The simulation tool and the real-time system which support the development and demonstration of the algorithms, respectively, also are described, and finally the plans for testing the capability are discussed briefly. Author

N87-24948# Naval Air Development Center, Warminster, Pa.
MACHINE ARCHITECTURES FOR ARTIFICIAL INTELLIGENCE COMPUTING **c60**
Raymond P. Kirsch and Christof H. Heithecker *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 11 p (For primary document see N87-24940 18-66)
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Alternatives to the von Neumann architectural model are under study by members of the advanced computer architecture community. Recent developments in multiprocessor technology can be shown to provide performance speed increases in the execution of expert systems. Several of these efforts are followed closely and are assessed. Author

N87-24949# Naval Air Development Center, Warminster, Pa.
NEW TECHNOLOGY IMPACTS ON FUTURE AVIONICS ARCHITECTURES **c06**
Richard S. Mejzak *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 7 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

An interpretation of avionics architecture is provided with respect to system components, organization, and design factors. Initially, general avionics architecture characteristics are addressed followed by discussions on emerging technologies and their impact on advanced systems. Information handling requirements are projected for future tactical aircraft. In addition, advanced avionics architecture design consideration and technical issues are addressed relative to achieving improved performance, reliability, survivability, flexibility, and low life cycle cost. Author

N87-24950# Marconi Avionics Ltd., Rochester (England). Guidance Systems Div.
THE DIGITAL COLOUR MAP SIMPLIFIES GROUND ATTACK OPERATIONS **c43**
David W. Hussey *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 8 p (For primary document see N87-24940 18-66)
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A pilot flying low and fast needs to know where he is at all times, the nature of the local terrain, and his actual track. The pilot needs help in identifying waypoints, threats, and targets without distraction of his attention from the safety of the aircraft and the overall demands of the mission. The ideal way to provide this information is as a continuous color map, oriented track up, with all associated information overlayed. It must also be usable by day and by night. No currently available equipment can achieve all these aims satisfactorily, other than a digital color map generator providing video to a multifunction color CRT display. Interest is now focussing on increasing the benefits that accrue from the use of the equipment in helicopter and fixed wing aircraft, in training, operationally, and as an aid to mission planning. The ease with which the digital map database can be updated and overlayed is a factor. It is as useful during mission planning as it is to the pilot in the air. How such a computer aid might be used and some of the increases in effectiveness that follow are identified. Author

N87-24951# Naval Weapons Center, China Lake, Calif.
CONSOLIDATED LAND ATTACK MISSION PLANNING STATION (CLAMPS)

Robert T. Hintz, M. J. Boyd, and D. Lubben *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 14 p (For primary document see N87-24940 18-66)
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The proposed mission planning station described is a result of a Naval Weapons Center discretionary funded study performed in conjunction with the AV-8B Program Office in 1985. The approach described draws heavily on the development and deployment of digital map technology for use on modern attack aircraft. The characteristics of the digital map are derived from a draft product specification currently being prepared for submission to the Defense Mapping Agency (DMA), and the AV-8B requirements document for a digital map capability. The envisioned digital map would utilize optical disk storage for the map, and additional solid state storage for the annotation generated by the planning station. The mission planning station is shown in three configurations ranging from a baseline capability (which may even be appropriate for an individual aircraft), up to a fully capable station capable of interacting with other digital data bases and even generating its own optical disk. Author

N87-24952# National Aerospace Lab., Amsterdam (Netherlands).
AUTOMATION STRATEGY AND RESULTS FOR AN AIRBASE COMMAND AND CONTROL INFORMATION SYSTEM (ABCCIS)
R. P. deMoel and W. N. vanDranen (Royal Netherlands Air Force, The Hague.) *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 18 p (For primary document see N87-24940 18-66)
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Automation is considered the appropriate way to improve the effectivity of preparation and deployment of weapon systems in the increasingly complex scene of battle. This automation is aiming for the support of the activities, because, according to the opinion of the RNLAF, human intellectural capacity is essential to a balanced commercial and control process. Human intelligence and creativity combined with speed and storage capacity of the computer may improve the quality of the preparation and the effectivity of the deployment of weapon systems. Author

N87-24953# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
CURRENT STATE OF AN EXPERT SYSTEM [TENUE A JOUR DE SITUATION PAR SYSTEME EXPERT]
Gerard Kitten and Loic leGuisquet *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 4 p In FRENCH (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

Artificial intelligence methods are discussed in the context of decision aid systems employed by the french tactical air force. In particular, the development and use of an expert system for military C3I (command, control, communications and intelligence) is addressed. M.G.

N87-24954# Electronic System G.m.b.H., Munich (West Germany).
COMPUTER AIDED SENSOR PLACEMENT OPTIMIZATION
A. Kainzinger and W. Rath *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 7 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

The problem of optimal sensor placement increases with the mobility of the sensors. Threats e.g., caused by missile technologies lead to sensor systems, where some of the sensors are highly mobile. Thus the optimization of sensor placement for a given surveillance area becomes a complex and time critical task if constraints (operations areas, terrain ondulation, terrain accessability, sensor capabilities, tactical objectives, and assumed tactical objective of the WP forces) are taken into account. A layer model is presented for the computer aided stepwise optimization of sensor placement. The computer tool is based on digitized terrain data containing information about the height and cultures. The layer model is based on interactive procedures and automatic decision guidance. The software can be installed on minicomputers with a color display and color printer thus making it a mobile transportation tool which can be used online in the field. Author

N87-24955# Marconi Avionics Ltd., Rochester (England). Airborne Display Div.
AN INTEGRATED AIRCRAFT NAVIGATION AND DISPLAY SYSTEM UTILISING AN ON-BOARD COMPOSITE DATA BASE
M. L. Busbridge and D. J. Puleston *In* AGARD Advanced Computer Aids in the Planning and Execution of Air Warfare and Ground Strike Operations Feb. 1987 4 p (For primary document see N87-24940 18-66)
Copyright Avail: NTIS HC A07/MF A01

It is likely that future aircraft will contain a central data base containing feature details, ground elevation, low flying obstruction data, intelligence, and mission data. Recent advances in technology have made it possible to implement such a data base within an aircraft. The existence of a central data base facilitates many functions for both low level ground attack and air defense aircraft. These functions include: improved moving map displays, precision navigation systems, covert radar shadowing, surface to air missile site intervisibility, and perspective terrain displays for use in adverse visibility conditions. The integration of such a system is currently being finalized and forms part of an ongoing flight trials program in fixed wing jet aircraft. Author

N87-24956# Lawrence Livermore National Lab., Calif.
PROTECTING US SPACE ASSETS FROM ANTI-SATELLITE WEAPONS
S. Fetter and M. M. May May 1986 27 p Presented at the Conference on High Technologies and Reducing the Risk of War, New York, N.Y., 7 May 1986
(Contract W-7405-eng-48)
(DE87-008207; UCRL-94365; CONF-8605244-1) Avail: NTIS HC A03/MF A01

Over the years, the United States has become increasingly dependent on space-based assets to support its military policies. Satellite systems are required to a considerable extent to carry out nuclear operations and to support military forces during a conventional war. Current and future anti-satellite (ASAT) technologies may be capable of preventing these systems from carrying out their mission, thereby possibly decreasing the stability of deterrence. This paper explores what can be done to safeguard our space assets. DOE

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

N87-24957# Oak Ridge National Lab., Tenn.
EXTENSION OF O-THEORY TO PROBLEMS OF LOGICAL INFERENCING
E. M. Oblow Mar. 1987 49 p
(Contract DE-AC05-84OR-21400)
(DE87-007834; ORNL/TM-10107; CESAR-87/05) Avail: NTIS HC A03/MF A01

This paper extends Operator-Uncertainty Theory (OT) to the problem of uncertainty propagation in logical inferencing systems. The OT algebra and propositional interpretations presented in previous papers are applied here to derive operators for logical inferencing in the presence of conflict and undecidability. Operators for propagating uncertainties through the logical operations of disjunction and conjunction are defined. In addition, new OT operators for implication, modus ponens and modus tollens are also proposed. The operators derived using the OT methodology are found to give rise to a four-valued logic similar to that used in computer circuit design. This framework allows uncertainty in inferencing to be represented in the form of rules convenient for

use in expert systems as well as logical networks. The theory is general enough to deal with questions of conflict and undecidability, and to propagate their effects through the most widely used inference operations. DOE

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N87-24958# Los Alamos National Lab., N. Mex.
TUNING PERMANENT MAGNETS WITH ADJUSTABLE FIELD CLAMPS
R. I. Schermer 1987 4 p Presented at the Particle Accelerator Conference, Washington, D.C., 16 Mar. 1987
(Contract W-7405-eng-36)
(DE87-007467; LA-UR-87-646; CONF-870302-47) Avail: NTIS HC A02

The effective length of a permanent-magnet assembly can be varied by adjusting the geometrical parameters of a field clamp. This paper presents measurements on a representative dipole and quadrupole as the field clamp is withdrawn axially or radially. The detailed behavior depends upon the magnet multipolarity and geometry. As a rule-of-thumb, a 3-mm-thick iron plate placed at one end plane of the magnet will shorten the length by one-third of the magnet bore radius. DOE

N87-24959# Joint Publications Research Service, Arlington, Va.
CHINA REPORT: SCIENCE AND TECHNOLOGY
2 Sep. 1986 104 p Transl. into ENGLISH from various Chinese articles
(JPRS-CST-86-035) Avail: NTIS HC A06/MF A01

Topics addressed include: national developments; applied sciences; physical sciences; environmental quality; nuclear physics; electro-optics; tunable lasers; robotics; pollution problems; plasma physics; and software market control. For individual titles, see N87-24960 through N87-24963.

N87-24960# Joint Publications Research Service, Arlington, Va.
SCHEME FOR TYPHOON WAVE CALCULATION IN NORTHERN PART OF SOUTH CHINA SEA **c48**
Jinghan Zhang and Shaoying Li *In its* China Report: Science and Technology 2 Sep. 1986 p 13-48 Transl. into ENGLISH from Nanhai Haiyang Kexue (Beijing, China), no. 1, May 1980 p 135-164 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

The major large waves appearing in the South China Sea are typhoon waves. Thus, in maritime engineering planning and the exploitation and use of marine resources it is necessary to consider the effects of typhoon waves. Predicition analysis of the waves bases on the motion of the typhoon, changes in strength, and other characteristics were studied. B.G.

N87-24961# Joint Publications Research Service, Arlington, Va.
FIELD IN SINGLE-MODE HELICALLY WOUND OPTICAL FIBERS **c74**
Xisheng Fang and Zongqi Lin *In its* China Report: Science and Technology 2 Sep. 1986 p 49-59 Transl. into ENGLISH from Tongxin Xuebao (Beijing, China), v. 6, no. 4, Oct. 1985 p 70-75; 91 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

The coupled-mode equations of the scalar field of the fundamental mode in single-mode helically wound optical fibers with circular cross-section are obtained by using the Maxwell equations in the local orthogonal curvilinear coordinate system introduced by Tang and the weakly guiding boundary condition. Two main results are brought about via the perturbation expansion of the field and the propagation constants. The field in the afore-mentioned fiber maintains a quasilinear state of polarization (SOP) while its orientation rotates with a rotation rate close to -Tau with respect to the Serret-Frenet frame. The SOP of the above field changes periodically along the propagation distance s from l to a value a little less than 1, and for a fixed s, it changes periodically according to the incident polarized angle with a period Pi/2. The theoretical results are consistent with the published experimental data on liquidcore fibers. Author

N87-24962# Joint Publications Research Service, Arlington, Va.
THEOREM PROPOSED REGARDING P-NP PROBLEM **c76**
Jie Wang *In its* China Report: Science and Technology 2 Sep. 1986 p 60-62 Transl. into ENGLISH from Kexue Tongbao (Beijing, China), v. 30, no. 10, May 1985 p 792-793 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

Baker, et al,. were the first to use relativization studies on the problem P = ?NP, which obtained penetrating results. The necessary and sufficient conditions are discussed where for an arbitrary language B there is an existing language A that allows P sup A = PN sup B. Author

N87-24963# Joint Publications Research Service, Arlington, Va.
HIGH-POWER TUNABLE ALEXANDRITE LASER WITH GIANT PULSE OUTPUT, SHG **c36**
Bangxing Zhang, Lusheng Wu, Meirong Zhao, and Haili Zhang *In its* China Report: Science and Technology 2 Sep. 1986 p 64-69 Transl. into ENGLISH from Guangxue Xuebao (Shanghai, China), v. 6, no. 5, May 1986 p 408-412 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

The first tunable Q-switch alexandrite laser in China with high power and giant pulse output is described. A tunable range of 730 to 790 nm, linewidth of 0.8 nm, pulse width of 30 ns, and peak power of 10 MW were achieved. Using a LiIO3 crystal as a frequency doubler, the SHG tunable range of 368 to 393 nm and power conversion efficiency of 9% were obtained. Author

N87-25027# Eotvos Lorand Univ., Budapest (Hungary). Dept. of Atomic Physics.
COSMOS AND PEOPLE
George Marx *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 7-11 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25032# Kansas State Univ., Manhattan. Dept. of Physics.
SKYLAB PHYSICS: LESSONS FOR 12-14 YEAR OLD PUPILS
Dean Zollman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 37-41 (For primary document see N87-25026 18-89)
(Grant NSF SED-79-18986)
Copyright Avail: NTIS HC A20/MF A01

N87-25033# Open Univ., Oxford (England).
IDEAS FOR EDUCATIONAL PHYSICS EXPERIMENTS IN SPACE
David A. Blackburn *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 43-46 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25052# New York State Dept. of Education, Albany. Bureau of Science Education.
PRACTICAL APPLICATIONS OF BASIC PHYSICS IN SPACE EXPLORATION
S. A. Agruso and John D. FitzGibbons *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 155-158 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25053# Technische Univ., Munich (West Germany). Sektion physik.
SUGGESTION FOR A DEMONSTRATION IN SPACELAB: PLANETARY MOTION BY COULOMB FORCE

Karl Luchner *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 159-161 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25098# Parainen Secondary School (Finland).
THE 40M OPEN AIR FOUCAULT PENDULUM OF EURAJOKI WATER TOWER, FINLAND
Jukka O. Mattila *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 393-394 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

N87-24964*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
AN EXPERIMENTAL STUDY OF SURFACE PRESSURE FLUCTUATIONS IN A SEPARATING TURBULENT BOUNDARY LAYER
Roger L. Simpson, M. Ghodbane, and B. E. McGrath Jun. 1987 83 p
(Grant NAG1-317)
(NASA-CR-178309; NAS 1.26:178309) Avail: NTIS HC A05/MF A01 CSCL 20A

Measurements of streamwise velocity fluctuation and surface pressure fluctuation spectra and wavespeeds are reported for a well-documented separating turbulent boundary layer. Because a portion of the acoustic pressure fluctuations is the same across the nominally two-dimensional turbulent flow, it is possible to decompose two microphone signals and obtain directly the turbulent flow contributions to the surface pressure spectra. The rms surface pressure fluctuation p' and spectra phi(omega) increase through the adverse pressure gradient attached flow region and the detached flow zone and scale on the maximum turbulent shearing stress tau(M); p'/tau(M) increases to the detachment location and decreases downstream due to the rapid movement of the pressure-fluctuation-producing motions away from the wall after the beginning of intermittent backflow. At lower frequencies for the attached flow phi(omega) is approximately omega to the -0.7 while phi(omega) is approximately omega to the -3 at higher frequencies. After the beginning of intermittent backflow, phi(omega) varies with omega at low frequencies and omega to the -3 at high frequencies; farther downstream the lower frequency range varies with omega to the 2.4. The surface pressure fluctuation celerity for the attached flow increases with frequency and agrees with the semi-logarithmic overlap equation of Panton and Linebarger. After the beginning of the separation process, the wavespeed decreases because of the oscillation of the instantaneous wavespeed direction and the streamwise coherence decreases drastically. Author

N87-24965*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACOUSTIC FATIGUE: OVERVIEW OF ACTIVITIES AT NASA LANGLEY
John S. Mixson and Louis A. Roussos Apr. 1987 40 p Presented at the AIAA Dynamics Specialists Conference, Monterey, Calif., 9-10 Apr. 1987
(NASA-TM-89143; NAS 1.15:89143) Avail: NTIS HC A03/MF A01 CSCL 20A

A number of aircraft and spacecraft configurations are being considered for future development. These include high-speed turboprop aircraft, advanced vertical take-off and landing fighter aircraft, and aerospace planes for hypersonic intercontinental cruise or flight to orbit and return. Review of the acoustic environment expected for these vehicles indicates levels high enough that acoustic fatigue must be considered. Unfortunately, the sonic fatique design technology used for current aircraft may not be adequate for these future vehicles. This has resulted in renewed emphasis on acoustic fatigue research at the NASA Langley Research Center. The overall objective of the Langley program is to develop methods and information for design of aerospace vehicles that will resist acoustic fatigue. The program includes definition of the acoustic loads acting on structures due to exhaust jets of boundary layers, and subsequent determination of the stresses within the structure due to these acoustic loads. Material fatigue associated with the high frequency structural stress reversal patterns resulting from acoustic loadings is considered to be an area requiring study, but no activity is currently underway. Author

N87-24966*# Cambridge Acoustical Associates, Inc., Mass.
PREDICTIONS OF WING AND PYLON FORCES CAUSED BY PROPELLER INSTALLATION
Rudolph Martinez May 1987 82 p
(Contract NAS1-18020)
(NASA-CR-178298; NAS 1.26:178298; U-1411-349.10) Avail: NTIS HC A05/MF A01 CSCL 20A

Replacement of current turbojets by high-efficiency unducted propfans could have the unfortunate side effect of increasing cabin noise, essentially because unsteady-aerodynamic mechanisms are likely to be introduced whereby some of the energy saved may be lost again, to the production of propeller noise and to wing/pylon vibrations coupling to the cabin as a sounding board. The present study estimates theoretically associated harmonic aerodynamic forces for two candidate configurations: a pusher propeller which chops through the mean wake of the pylon supporting it, and in the process generates a blade-rate force driving the structure, and a tractor wing-mounted propeller, whose trailing rotating wake induces an unsteady downwash field generating unsteady wing airloads. Reported predictions of such propfan aerodynamic sources of structure-borne sound, or vibration, could be the basis for devising means for their mechanical isolation, and thus for the effective interruption of the structural noise path into the cabin. Both mechanisms are analyzed taking advantage of the high subsonic Mach number and high reduced frequency of the interaction between the impinging flow and the affected aerodynamic element. Author

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N87-24967 Paris-Sud Univ., Orsay (France).
EXPERIMENTAL EVIDENCE OF THE INTERMEDIATE BOSONS W(+ OR -) AND Z(0) DEG IN PROTON-ANTIPROTON COLLISIONS AT 546 GeV IN THE MASS CENTER. UA2 EXPERIMENT Ph.D. Thesis [MISE EN EVIDENCE DES BOSONS INTERMEDIAIRES W+- ET Z(0) DANS LES COLLISIONS PROTON-ANTIPROTON A 546 GEV DANS LE CENTRE DE MASSE - EXPERIENCE UA2]
Sotiris Loucatos 1985 193 p In FRENCH; ENGLISH summary
(ETN-87-99556) Avail: NTIS Issuing Activity

The intermediate vector bosons were observed through 40 decays. Cross sections of W(+ or -) and Z(0) and the weak interaction parameters are determined. The results are in agreement with standard model predictions. An upper limit to the total width of Z(0) is given. An upper limit to the number of additional neutrinos is inferred. Radiative decays of the intermediate vector bosons are discussed. ESA

N87-24968 Paris-Sud Univ., Orsay (France).
MEASUREMENT OF NUCLEAR TOTAL PHOTOABSORPTION CROSS SECTION IN THE DELTA (1232) RESONANCE REGION FOR THE C12 AND Pb 208 ATOMIC NUCLEI Ph.D. Thesis [MESURE DES SECTIONS EFFICACES D'ABSORPTION NUCLEAIRE TOTALE DE PHOTONS DANS LA REGION DU DELTA (1232). NOYAUX ETUDIES 12C ET 208PB]

Lotfi Ghedira 1985 168 p In FRENCH; ENGLISH summary
(ETN-87-99559) Avail: NTIS Issuing Activity

The measurement of the hadronic products emitted during the absorption process is described. A tagged photon beam obtained by flight annihilation of positrons was used. The reaction target is placed inside a cylindrical NaI scintillator covering 93% of the outlet surface. Charge multiplicity was also detected. The total number of hadronic events detected is 70% to 80%. The total hadronic cross section is found to be close to 400 microb/nucleon for C and Pb. ESA

N87-24969 Paris-Sud Univ., Orsay (France).
STUDY OF THE ELECTROMAGNETIC FORM FACTORS OF DEUTERIUM BY ELECTRON SCATTERING Ph.D. Thesis [ETUDE DES FACTEURS DE FORME ELECTROMAGNETIQUES DU DEUTERIUM PAR DIFFUSION D'ELECTRONS]
Sylvie Auffret 1985 161 p In FRENCH; ENGLISH summary
(ETN-87-99560) Avail: NTIS Issuing Activity

The magnetic form factors B(q sq) are studied, as they are very sensitive to the tensor part of the deuteron wave function. Measurements are performed at incident energies ranging from 300 to 700 MeV. A liquid deuterium target, cooled with liquid hydrogen, was used. The predictions obtained from reasonable nucleon-nucleon protentials are in very good agreement with the results, but relativistic calculations are in clear disagreement with the experiment. The possible reasons are discussed. ESA

N87-24970 Paris-Sud Univ., Orsay (France).
RARE OXIDATION STATES OF GROUP 5 METAL COMPOUNDS GENERATED BY RADIOLYSIS IN NONAQUEOUS SOLVENTS: EXPERIMENTAL AND THEORETICAL STUDY. ATTEMPTS AT SYNTHESIS OF HETEROMETALLIC COMPLEXES CONTAINING NIOBIUM AND URANIUM OR THORIUM Ph.D. Thesis
Brigitte LeMotais 1985 215 p In FRENCH; ENGLISH summary
(ETN-87-99563) Avail: NTIS Issuing Activity

Monoculear and binuclear complexes of trivalent metals coordinated with gamma-picolin molecules and C1 atoms were oxidized and reduced by the radical ions CH2C12(+) or CH3CN(-) radiolytically generated in deoxygenated dichloromethane or acetonitrile. The mechanisms of these reactions are established from kinetic data or from EPR measurements. ESA

N87-24971 Paris-Sud Univ., Orsay (France).
LATTICE GAS MODELS FOR PARTICLE SYSTEMS IN AN UNDERDAMPED HOPPING REGIME Ph.D. Thesis [MODELES DE GAZ SUR RESEAU APPROPRIEES A L'ETUDE DE SYSTEMES DE PARTICULES EN REGIME DE SAUT SOUS-AMORTI]
Thierry Gobron 1986 151 p In FRENCH; ENGLISH summary
(ETN-87-99566) Avail: Issuing Activity

A model in which the state of the particle is described by a multicomponent vector, each possible kinetic state for the particle being associated with one of the components is presented. A master equation describes the evolution of the probability distribution in an independent particle model. From the master equation and with the help of the symmetry group that leaves the state transition operator invariant, physical quantities such as the diffusion constant are explicitly calculated for several lattices in one, two, and three dimensions. A Boltzmann equation is established and compared to the Rice and Roth proposal. ESA

N87-24972 Paris-Sud Univ., Orsay (France).
ENERGY TRANSFER BETWEEN METASTABLE NITROGEN MOLECULES N2(A3 SIGMA) AND OXYGEN ATOMS AND MOLECULES Ph.D. Thesis [TRANSFERTS D'ENERGIE ENTRE LES MOLECULES METASTABLES D'AZOTE N2(A3 SIGMA) ET LES ATOMES ET MOLECULES D'OXYGENE]
Antonio Rogerio DeSouza 1986 245 p In FRENCH
(ETN-87-99568) Avail: Issuing Activity

Emission spectroscopy, absorption spectroscopy, and mass spectroscopy were used to study the reaction coefficients in N-O reactions. The experimental device includes gas flow control, temperature control, and electric discharge excitation. The values of the reaction coefficients and the temperature effects are given. It is found that N2O is not produced in large quantities, being only 2% of the reaction products. ESA

N87-24973 Paris-Sud Univ., Orsay (France).
DETERMINATION OF MOLECULAR WAVE FUNCTIONS IN IMPULSION SPACE: FROM H2 TO Hn (n = INF.) Ph.D. Thesis [DETERMINATION DE FONCTIONS D'ONDE MOLECULAIRES DANS L'ESPACE DES IMPULSIONS: DE H2 A HN (N=INF.)]
Mireille Defranceschi 1985 145 p In FRENCH
(ETN-87-99572) Avail: Issuing Activity

A numerical iterative solution of the wave equations describing molecules such as H2, H3, Li2, and more complex systems in the impulsion space is presented. The method to obtain the algorithms is discussed. The method permits the acquisition of numerical wave functions of molecules with more than two atoms. The functions are used to study impulsion density distribution and theoretical Compton profiles. ESA

N87-24974 Paris-Sud Univ., Orsay (France). Lab. de Photophysique Moleculaire.
IMPLEMENTATION OF A BEAM-GAS DEVICE TO STUDY THE REACTIVE COLLISION Mg+Cl2=MgCl+Cl USING LASER SPECTROSCOPY OF THE MgCl RADICAL [REALISATION D'UN DISPOSITIF 'JET-GAZ' POUR L'ETUDE DE LA COLLISION REACTIVE Mg+Cl2=MgCl+Cl PAR SPECTROSCOPIE LASER DU RADICAL MgCl]
Mohammed Ali Gargoura 1986 156 p In FRENCH; ENGLISH summary
(ETN-87-99573) Avail: Issuing Activity

The experimental set-up used to study reactive collisions by chemiluminescence or laser-induced fluorescence is described. The events are studied in single collision conditions, that is before secondary collisions modify initial energy distribution in the products. A technique of detection of very low intensity atomic beams by using fluorescence with a hollow cathode is described. Spectroscopic data transition of the MgCl radical is improved, and results of the dynamics of the reaction are given. ESA

N87-24975 Paris-Sud Univ., Orsay (France).
CROSSED BEAM STUDY OF REACTIVE COLLISIONS H2/O AT SEVERAL EXCITED STATES Ph.D. Thesis [REALISATION ET ETUDE PAR FAISCEAUX MOLECULAIRES CROISES DES REACTIONS CHIMIQUES H2/O A PLUSIEURS ETATS EXCITES]
Jacqueline Marx 1986 285 p In FRENCH; ENGLISH summary
(ETN-87-99574) Avail: Issuing Activity

Reactions involving H2/O collisions, as found in the chemistry of the upper atmosphere and in the combustion of hydrogen are discussed. Atomic oxygen is produced in its excited state in a radio frequency discharge which dissociates the molecular oxygen seeded in a carrier gas. The hydrogen molecules are excited vibrationally by electron bombardment. Time of flight measurements show the competition between the abstraction and insertion-dissociation mechanisms. The analysis of the spontaneous fluorescence of OH radicals reveals a very hot and non-Boltzmannn rotational excitation. ESA

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

N87-24976# Los Alamos National Lab., N. Mex.
SPACE-CHARGED-INDUCED EMITTANCE GROWTH IN THE TRANSPORT OF HIGH-BRIGHTNESS ELECTRON BEAMS
M. E. Jones and B. E. Carlsten Mar. 1987 4 p Presented at the Particle Accelerator Conference, Washington, D.C., 16 Mar.

1987
(Contract W-7405-eng-36)
(DE87-007460; LA-UR-87-415; CONF-870302-62) Avail: NTIS HC A02

The emittance induced by space charge in a drifting beam of finite length has been investigated, and a scaling law has been obtained from simple considerations of the different rates of expansion of different portions of the beam. The scaling law predicts the initial rate of emittance growth, before the beam shape has distorted significantly, and thus represents an upper bound on the rate of emittance increase. This scaling law has been substantiated by particle-in-cell simulation and the dependence on geometric factors evaluated for specific choices of the beam profile. For long, axially nonuniform beams, the geometric factors have been evaluated explicitly for Gaussian profiles, and other shapes. DOE

N87-24977*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
POSSIBLE COMPLEMENTARY COSMIC-RAY SYSTEMS: NUCLEI AND ANTINUCLEI
Warren W. Buck, John W. Wilson, Lawrence W. Townsend, and John W. Norbury (Idaho Univ., Moscow.) Jul. 1987 47 p
(NASA-TP-2741; L-16275; NAS 1.60:2741) Avail: NTIS HC A03/MF A01 CSCL 20H

Arguments are presented for the possible existence of antinuclei of charge Absolute Value of Z greater than 2 and particularly galactic cosmic antinuclei. Theoretical antinucleus-nucleus optical model cross sections are calculated and presented for the first time. A brief review of the nucleon-antinucleon interaction is also presented and its connection with the antinucleus-nucleus interaction is made. The predicted cross sections are smooth and show no structure. Finally, the findings are tied together with the formation of microlesions in living tissue. Author

N87-24978 Paris-Sud Univ., Orsay (France).
FRAGMENTATION AND DIRECT TRANSFER REACTIONS FOR AN Ar40 INCIDENT BEAM ON Al27 TARGET AT 1760 MeV Ph.D. Thesis
Ousmane Cisse 1985 92 p In FRENCH; ENGLISH summary
(ETN-87-99558) Avail: NTIS Issuing Activity

Peripheral collision studies are presented. A detailed analysis of the energy spectra of the fragments resulting from collision was carried out and interpreted in terms of a direct diffractional transfer model. For large mass transfer reactions, abrasion is the suitable mechanism. Results agree with participant spectator models. It is shown that fragmentation and transfer reactions can be discerned in this type of interaction. It is also indicated that the separation energy of the participants from the spectator nucleus, at least within the framework of the model, can be interpreted in terms of a friction force which becomes more efficient as the projectile energy decreases. ESA

N87-24979# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Material- und Festkoerperforschung.
CONTROLLABLE IRRADIATION FACILITIES FOR THE COMPACT SODIUM-COOLED NUCLEAR REACTOR FACILITY KNK 2
L. Schmidt, H. Lehning, K. Mueller, and G. Reimann Dec. 1986 30 p In GERMAN; ENGLISH summary
(KfK-4149; ISSN-0303-4003; ETN-87-99651) Copyright Avail: NTIS HC A03/MF A01

A materials irradiation facility was built in order to perform experiments at five core positions of the KNK 2 reactor. Two locations were provided with openings in the reactor lid for measurement and supply lines; they are therefore suited for the accomodation of instrumented test rigs. The two locations are the central core position at which an irradiation channel was realized with the help of a special carrier fuel element, and a reflector position. For the central position an irradiation rig was developed in which eight electrically heated pressure tube specimens can be irradiated simultaneously. The test conditions such as temperature and internal pressure can be adjusted individually for each specimen in a steady state or dynamic mode. For the reflector position a test rig is available in which the specimens are irradiated in electrically heated capsules. Another test rig serves for in-pile testing of switches for reactor protection systems. ESA

74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

N87-24980# Naval Ocean Systems Center, San Diego, Calif.
ABSORPTION AT OPTICAL WAVELENGTHS IN A PLASMA AEROSOL Final Report, Jun. - Oct. 1986
M. Shensa and J. Fitchek Dec. 1986 24 p
(AD-A179178; NOSC/TR-1158) Avail: NTIS HC A02/MF A01 CSCL 04A

The absorption of radiation at optical wavelengths (3 cm to 0.3 micrometers) in a plasma aerosol is examined. In particular, the mean free path is plotted as a function of wavelength for temperatures appropriate to laser-induced gas breakdown. Various formulae, one assumption used in their derivations, and their regions of validity are discussed. GRA

N87-24981 Paris-Sud Univ., Orsay (France).
STUDY OF BISTABLE OPTICAL DEVICES USING INTENSITY COUPLED HIGH GAIN LASERS. THEORETICAL AND EXPERIMENTAL ASPECTS Ph.D. Thesis [ETUDE DE DISPOSITIFS OPTIQUES BISTABLES UTILISANT DES LASERS A FORT GAIN COUPLES EN INTENSITE. ASPECTS THEORIQUES ET EXPERIMENTAUX]
Reuven Kuszelewicz 1986 202 p In FRENCH; ENGLISH summary
(ETN-87-99569) Avail: Issuing Activity

The bistable effect is obtained by competition between lasers. The light emission of one of them is injected into the active medium of the second one and vice-versa. Passive backward coupling through four-wave mixing is analyzed. This leads to three experimental configurations: angular misalignment, orthogonal polarization, and wavelength shifting. A theoretical model based on mean field and slowly varying envelope approximations is developed with semiconductor laser materials. Switching times of 100 psec are predicted. A demonstration with dye lasers leads to switching times shorter than 700 psec. ESA

N87-24982# Telefunken Electronic G.m.b.H., Heilbronn (West Germany).
HIGH BANDWIDTH INTEGRATED OPTICAL RECEIVERS Final Report, Jun. 1985
Peter Mischel Bonn, West Germany BMFT Dec. 1986 81 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-113; ISSN-0340-7608; ETN-87-99700) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 17

Monolithic integrated optical receivers (Opto-IC) with linear and digital functional units, and a light emitting diode (LED) based on GaAlAs were developed. The components are used in optical data transmission systems with high bandwidth. Due to the contradictory requirements in the design of the photodiode and the IL components, the realization of the Opto-IC included the development of circuit design and technological processes. The adjustment of the Al contents and doping concentrations, as well as the investigation of the element structure, result in an optimum luminous efficiency and signal rise and fall times for the GaAlAs LED's. Using these components in optocouplers, signal transmission bandwidths of 5 MHZ (with linear Opto-IC), or data transmission rates of 6 Mbit/sec (with Schmitt-trigger Opto-IC) are achieved. ESA

N87-24983# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering and Computer Science.
ON 2-D BISTABLE OPTICAL CIRCUITS Final Report, 1 Sep. 1984 - 30 Nov. 1985

Cardinal Warde 30 Jan. 1987 39 p
(Grant AF-AFOSR-0358-84)
(AD-A179964; AFOSR-87-0420TR) Avail: NTIS HC A03/MF A01 CSCL 09E

This final report summarizes a investigation of: (1) two dimensional arrays of bistable optical elements and circuits based on microchannel spatial light modulator (MSLM) technology; (2) an investigation of the possible applications of the balanced ternary system (BTS) in digital optical processing and (3) a preliminary study of the design of hybrid optical inference machines. The bistable circuit arrays employ optical feedback around an MSLM, and a novel device called the beamlet from a single input laser beam. A general purpose versatile circuit is discussed as well as systems for phase-driven bistability and amplitude-driven bistability. In the BTS study, it is shown that the BTS offers several advantages over the conventional binary system. These include more efficient use of optical power and space-bandwidth product coupled with increased dynamic range when performing multiplication. Finally, in the symbolic processing program, two novel hybrid optical architectures are proposed for parallel symbolic inference on electronic knowledge bases. GRA

N87-24984*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
OPTICAL DATA TRANSFER SYSTEM FOR CROSSING A ROTARY JOINT Patent Application
Richard J. Wangler, inventor (to NASA) 23 Apr. 1987 19 p
(NASA-Case-LAR-13613-1-SB; NAS 1.71:LAR-13613-1-SB; US-Patent-Appl-SN-041388) Avail: NTIS HC A02/MF A01 CSCL 20F

A data transfer system for crossing a rotary joint is described which uses optical transmitters and receivers which require no physical contact therebetween. The optical transmitter is preferably formed from an optical fiber looped around the rotation axis of the rotary joint. The optical fiber preferably has a core which produces Rayleigh scattering encased by cladding which produces MIE scattering. The light which exits the cladding of the optical fiber is detected on the opposite side of the rotary joint by a photodetector. The photodetector may receive the transmitted light via a second optical fiber having a core encased by cladding and looped around the rotation axis in a manner similar to the optical fiber in the optical transmitter. The optical transmitter preferably uses a laser as a light generating means and two-way communication is made possible by using lasers and detectors tuned to two different wavelengths and connected to opposite ends of the optical fibers in the optical transmitter and receiver. NASA

N87-24497*# Air Force Weapons Lab., Kirtland AFB, N. Mex.
JOINT OPTICS STRUCTURES EXPERIMENT (JOSE)
David Founds *In* NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986 Jun. 1987 p 591-602 (For primary document see N87-24495 18-18)
Avail: NTIS HC A14/MF A01 CSCL 20F

N87-24753# Khartoum Univ. (Sudan).
OPTICAL AND DIGITAL SAR PROCESSING TECHNIQUES: A STATISTICAL COMPARISON OF ACCURACY USING SEASAT IMAGERY
Abdalla Elsadig Ali *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 131-139 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24767# Canada Centre for Remote Sensing, Ottawa (Ontario).
THE MULTIDETECTOR ELECTRO-OPTICAL IMAGING SENSOR (MEIS) 2 PUSHBROOM IMAGER: FOUR YEARS OF OPERATION
S. M. Till, R. A. Neville, W. D. McColl, and R. P. Gauthier *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 247-253 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24768# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
THE STEREO PUSHBROOM SCANNER SYSTEM DIGITAL PHOTOGRAMMETRY SYSTEM (DPS) AND ITS ACCURACY
Otto Hofmann *In* ESA Proceedings of the International Symposium on Progress in Imagery Sensors Nov. 1986 p 257-264 Previously announced as N87-17167 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24784# Technische Univ., Hanover (West Germany). Inst. for Photogrammetry and Engineering Surveys.
PHOTOGRAMMETRIC DATA ACQUISITION USING THE DIGITAL RESEAU-SCANNING SYSTEM ROLLEIMETRIC RS
Thomas Luhmann and Wilfried Wester-Ebbinghaus *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 381-384 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24805# National Research Council of Canada, Ottawa (Ontario). Photogrammetric Research Section.
A NEW TEST FACILITY FOR THE DETERMINATION OF THE IMAGE QUALITY OF PHOTOGRAMMETRIC LENSES
Hartmut Ziemann *In* ESA Proceedings of the International Symposium on Progress in Imaging Sensors Nov. 1986 p 557-563 (For primary document see N87-24738 18-43)
Copyright Avail: NTIS HC A99/MF A01

N87-24961# Joint Publications Research Service, Arlington, Va.
FIELD IN SINGLE-MODE HELICALLY WOUND OPTICAL FIBERS
Xisheng Fang and Zongqi Lin *In its* China Report: Science and Technology 2 Sep. 1986 p 49-59 Transl. into ENGLISH from Tongxin Xuebao (Beijing, China), v. 6, no. 4, Oct. 1985 p 70-75; 91 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N87-24985*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN EXPERIMENTAL STUDY OF LASER-SUPPORTED PLASMAS FOR LASER PROPULSION: CENTER DIRECTOR'S DISCRETIONARY FUND PROJECT DFP-82-33 Final Report
R. H. Eskridge, T. D. McCay, and D. M. VanZandt Jan. 1987 32 p Previously announced in IAA as A84-37979
(NASA-TM-86583; NAS 1.15:86583) Avail: NTIS HC A03/MF A01 CSCL 20I

The rudiments of a rocket thruster, which receives its enthalpy from an energy source which is remotely beamed from a laser, is described. An experimental study, now partially complete, is discussed which will eventually provide a detailed understanding of the physics for assessing the feasibility of using hydrogen plasmas for accepting and converting this energy to enthalpy. A plasma ignition scheme which uses a pulsed CO2 laser was develped and the properites of the ignition spark documented, including breakdown intensities in hydrogen. A complete diagnostic system capable of determining plasma temperature and the plasma absorptivitiy for subsequent steady-state absorption of a high power CO2 laser beam are developed and demonstrative use is discussed for the preliminary case study, a two atmosphere laser supported argon plasma. Author

N87-24986 Paris-Sud Univ., Orsay (France).
THEORETICAL AND EXPERIMENTAL STUDY OF CYCLOTRON IONIC HEATING IN THE TFR TOKAMAK Ph.D. Thesis [ETUDE THEORIQUE ET EXPERIMENTALE DU CHAUFFAGE CYCLOTRONIQUE IONIQUE SUR LE TOKAMAK TFR]
Didier Gambier 1985 244 p In FRENCH; ENGLISH summary
(ETN-87-99557) Avail: NTIS Issuing Activity

Cyclotron resonance heating effects are studied. In the frame of the WKB approximation, an algorithm to derive the connection formulas that connect the set of waves on each side of the conversion layer is presented. Using a variational principle, the effect of the resonance on the amplitude of the perturbed field generated by the antenna set is analyzed. The experimental results obtained on the TFR Tokamak are reported. The role of conversion in the damping of the ICFR power is clear. Impurity production during ICRH is considered. ESA

N87-24987 Paris-Sud Univ., Orsay (France).
MODELING ELECTRONIC KINETICS IN A WEAKLY IONIZED GAS Ph.D. Thesis [MODELISATION DE LA CINETIQUE ELECTRONIQUE DANS UN GAZ FAIBLEMENT IONISE]
Jean-Pierre Boeuf 1985 252 p In FRENCH; ENGLISH summary
(ETN-87-99562) Avail: NTIS Issuing Activity

Electron motions in gases are discussed, including numerical techniques to solve the Boltzmann equation. Relaxation phenomena toward equilibrium under a uniform electric field, and the question of the existence of the hydrodynamic regime are studied. The coupling between electronic kinetics and chemical kinetics due to second kind collisions in nitrogen is analyzed. A quantitative description of the evolution of the energy balance, accounting for electron molecule energy transfer is given. Electron kinetics in space charge distorted, highly nonuniform electric fields is also investigated. ESA

N87-24988# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de la Physique Generale.
ANTI-STOKES COHERENT RAMAN DIFFUSION STUDY OF A MULTIPOLAR HYDROGEN PLASMA Final Report [ETUDE PAR DRASC D'UN PLASMA MULTIPOLAIRE DE H2]
M. Lefebvre and M. Pealat May 1986 51 p In FRENCH
(Contract DRET-84-001)
(ONERA-RF-42/7131-PY; ETN-87-99623) Avail: NTIS HC A04/MF A01

A low pressure H2 plasma created under magnetic confinement is studied to determine the space-time distribution of the rotation/vibration state populations. The plasma generator and the optical instruments are described. The measurements show the importance of collisions with the wall to damp vibration, while the rotation relaxation is mainly dependent on molecule to molecule collisions. ESA

N87-24989# Nagoya Univ. (Japan). Inst. of Plasma Physics.
MEASUREMENT OF RADIATION POWER FROM THE JIPP T-IIU TOKAMAK PLASMA
Isamu Ogawa Apr. 1987 102 p
(IPPJ-826; ISSN-0469-4732) Avail: NTIS HC A06/MF A01

Characteristics of a pyroelectric detector, a metal-film bolometer, and a thermistor are investigated in order to attain high reliability of the bolometric measurement. The spurious signal which appears on a pyroelectric detector was efficiently eliminated. The detector is calibrated with a HeNe laser taking the reflection on the detector surface into account. No temporal change was seen on the sensitivity of the detector calibrated by this method. A thin metal-film bolometer was developed with high sensitivity, high time response, and well defined thermal characteristics. The calibration of this detector was performed by supplying a bias current through its resistor. A bolometric system was constructed with high time response and high spatial resolution, which consisted of twelve pyroelectric detectors and a metal-film bolometer. The radiation power measured with the pyroelectric detector agrees with that measured with the calibrated metal-film bolometer within 5%. Spectroscopic and bolometric measurements with spatial and temporal resolution show that large radiation loss brings about the decrease in electron and ion temperatures and plasma energy. Carbon limiters have an effect to suppress the radiation power for ohmic plasma, but are insufficient for ICRF heated plasma. The main contribution to radiation power may be attributed to Fe impurity released from the ICRF antennae, the Faraday shield, and the vacuum vessel. Author

N87-24990# Nagoya Univ. (Japan). Inst. of Plasma Physics.
ENERGY EIGENVALUES OF HELIUM-LIKE ATOMS IN DENSE PLASMAS
Tasuke Hashino, Shinobu Nakazaki, Takako Kato, and Hiromichi Kashiwabara Apr. 1987 16 p
(IPPJ-824; ISSN-0469-4732) Avail: NTIS HC A02/MF A01

Calculations based on a variational method with wave functions including the correlation or electrons are performed to obtain energy eigenvalues of Schroedinger's equation for helium-like atoms embedded in dense plasmas, taking the Debye-Hukel approximation. Energy eigenvalues for the 1(sup 1)S, 2(sup 1)S, and 2(sup 3)S states are obtained as a function of Debye screening length. Author

N87-24991# Nagoya Univ. (Japan). Inst. of Plasma Physics.
PLASMA CURRENT STARTUP BY LOWER HYBRID WAVES IN THE JIPP T-IIU TOKAMAK
K. Toi, K. Ohkubo, K. Kawahata, Y. Kawasumi, K. Matsuoka, N. Noda, I. Ogawa, Y. Ogawa, K. Sato, S. Tanahashi et al. Apr. 1987 37 p
(IPPJ-823; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

The characteristic behaviors of lower hybrid current startup in JIPP T-IIU are described. The current startup is carried out by injection of 800 MHz lower hybrid waves (LHW) into cold and low density plasmas produced by electron cyclotron resonance or lower hybrid waves only. The plasma current rises up with a characteristic rise time and approaches a quasi-steady state value, when LHW power of 10 to 50 kW is injected into a torus, controlling the vertical field. The rise time is inversely proportional to the bulk electron density and is comparable to the collision time of current carrying high energy electrons with bulk plasmas. The effects of the initial injection of electron cyclotron heating power and the observed parametric instabilities on the current startup are investigated from a viewpoint of seed current generation. During rapid current rise when appreciably negative loop voltage is observed the bulk electrons are heated up to 150 eV. Various heating mechanisms responsible for the bulk electron heating are discussed. Author

N87-24992# Nagoya Univ. (Japan). Inst. of Plasma Physics.
LONG-TIME CORRELATION FOR THE CHAOTIC ORBIT IN THE TWO-WAVE HAMILTONIAN
Tadatsugu Hatori and Haruyuki Irie (Nihon Univ., Tokyo, Japan) Mar. 1987 36 p
(IPPJ-822; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

The time correlation function of velocity is found to decay with the power law for the orbit governed by a Hamiltonian, H=v sup 2/2 - Mcosx - Pcos (k(x-t)). The renormalization group technique can predict the power of decay for the correlation function defined by the ensemble average. The power spectrum becomes the 1/f-type for a special case. Author

N87-24993# Nagoya Univ. (Japan). Inst. of Plasma Physics.
LECTURE SERIES ON TURBULENT TRANSPORT IN TOKAMAKS
Ronald E. Waltz Mar. 1987 104 p Series held in Nagoya, Japan, Fall, 1986
(IPPJ-817; ISSN-0469-4732) Avail: NTIS HC A06/MF A01

This lecture series reviews recent research on the theory, simulation and phenomenology of turbulent transport in tokamaks. Simplified theoretical scaling models for drift wave transport have had considerable success in explaining many experimental features of tokamak confinement. The first lecture summarizes those successes and discusses the remaining difficulties of such models. The succeeding two lectures emphasized the theoretical basis of

the models by defining and numerically treating the nonlinear equations for homogeneous turbulence in an inhomogeneous magnetized plasma in both electrostatic and electromagnetic limits. Author

N87-24994# Nagoya Univ. (Japan). Inst. of Plasma Physics.
SAFETY ANALYSIS AND EVALUATION METHODOLOGY FOR FUSION SYSTEMS
Y. Fujii-e, Y. Kozawa, C. Namba, O. Konishi, M. Nishikawa, T. Yano, I. Yanagisawa, S. Kotake, T. Sawada, T. Mizushina et al. Mar. 1987 267 p
(IPPJ-816; ISSN-0469-4732) Avail: NTIS HC A12/MF A01

As a result of the study, safety analysis and evaluation methodology for fusion systems was developed. In the methodology, all the safety related issues concerned with a distributed system like a fusion system could be integrated and resolved with the logical consistency in progressing the safety analysis and evaluation. In the course of the methodology development, new ideas and approaches were presented, e.g., the general descriptive model (GDM), the three principal items to be assured, and approach to safety assurance based on the event categorization and function based on safety analysis. The characteristics of fusion systems were also summarized from a safety viewpoint. They could be harmonized within the framework of the methodology and the effectiveness of the approach according to the framework was demonstrated, where the requisite subjects and their relations in the methodology development were selected and organized. The usefulness of the methodology was confirmed through the application to the safety evaluation of the R-tokamak. This methodology could be a tool for realizing a rational fusion system design. Author

N87-24995# Nagoya Univ. (Japan). Inst. of Plasma Physics.
MACROSCOPIC STABILITY OF ROTATING AND PROPAGATING LIB
Takayuki Aoki and Keishiro Niu Mar. 1987 29 p
(IPPJ-821; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

The linear stabilities of a rotating and propagating light ion beam in a low density plasma are studied numerically on the basis of the hydromagnetic equations. The centrifugal force acts on the beam and the self-magnetic fields is induced by the rotating and propagating charged particles. To clarify the physical mechanism, a phenomenon appearing in a simple model is analyzed, and it is found that the centrifugal force and the magnetic field in the azimuthal direction play a role in stabilization. For such beam parameters practically required as the energy driver for inertial confinement fusion, the numerical results indicate that the beam in the equilibrium state tends to be stable if the ratio of the beam rotating velocity to the propagating one is more than the value of 0.8. Author

N87-24996# Nagoya Univ. (Japan). Inst. of Plasma Physics.
ELECTRON ENERGY INCREASE OF AN REB-RING BY MAJOR RADIUS COMPRESSION
Mitsuru Hasegawa and Kazumichi Narihara Mar. 1987 34 p
(IPPJ-820; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

Measurement of X-ray bremsstrahlung emitted from Relativistic Electron Beam (REB) rings formed in the SPAC-VI toroidal device elucidated that major radius compression of the ring raises the energies of the ring electrons. At the compression ratio of 2.0, the ring current rose from 24 to 50 kA. The highest electron energy that was estimated by the hard X-ray spectrum measurement increased from approximately 1 MeV to approximately 2 MeV. The energy distribution of REB was broadly spread. During the compression, the current of the ring I sub R and the major radius R are governed by the relationship I sub R x R = const. Some discussions on this relationship are given in which the energy spread of the beam electrons and the change in the magnetic flux enclosed by the ring are taken into consideration. Author

N87-24997# Nagoya Univ. (Japan). Inst. of Plasma Physics.
EXPERIMENT ON CURRENT DECAY OF INTENSE REB RING WITH A LARGE SELF-MAGNETIC ENERGY
Mitsuru Hasegawa, Kazumichi Narihara, Yukihiro Tomita, Shin Kubo, Masakazu Matsui, Tetsuya Tsuzuki, and Akihiro Mohri Mar. 1987 52 p Submitted for publication
(IPPJ-819; ISSN-0469-4732) Avail: NTIS HC A04/MF A01

Experimentation on intense Relativistic Electron Beams (REB) rings performed in the toroidal device SPAC-VI demonstrated that the time dependent self magnetic flux plays a fundamental role on the current decay of the ring under the collisions with the plasma and/or neutral particles. The momentum distribution or the beam electrons evolves self-consistently under the influence of the electric field induced by the decay of the REB ring current as well as the collisions. This mechanism was clearly observed by puffing hydrogen or argon gas on REB rings. Some examinations of experimental results are also given. Author

N87-24998# Nagoya Univ. (Japan). Inst. of Plasma Physics.
DETERMINATION OF PITCH ANGLES OF MAGNETIC FIELD LINES IN TOKAMAK WITH OBLIQUELY INJECTED HELIUM BEAM
Akihiro Mohri Apr. 1987 18 p
(IPPJ-825; ISSN-0469-4732) Avail: NTIS HC A02/MF A01

Pitch angles of magnetic field lines or q-profile in high density tokamaks can be determined by the method proposed here. Blobs of monoenergetic helium beam with different velocities are injected into the tokomak obliquely to the toroidal direction on a poloidal plane x. Produced He(+) ions move nearly along the magnetic field lines, and their front emitting a HeII line crosses a different sight plane and forms a curve on it. Optically measured shift of the curve from x leads to the distribution of pitch angle after correction of perpendicular drift motion of He(+) ions using the velocity dependence of the drift. Author

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N87-24999# Cornell Univ., Ithaca, N.Y. School of Electrical Engineering.
MICROWAVE SEMICONDUCTOR RESEARCH-MATERIALS, DEVICES AND CIRCUITS Annual Technical Report, 1 May 1985 - 30 Apr. 1986
L. F. Eastman, J. M. Ballantyne, C. L. Tang, W. H. Ku, and J. P. Krusius Mar. 1987 36 p
(Contract F49620-84-C-0060)
(AD-A179123; AFOSR-87-0336TR) Avail: NTIS HC A03/MF A01 CSCL 20L

This program covers the growth and assessment of gallium arsenide and related compounds and alloys for use in microwave, millimeter wave, and optical devices. It also covers the processing of the material into devices, the testing of the devices, and the theoretical modeling of carrier transport in these devices. Both molecular beam epitaxy (MBE) and organometallic vapor phase epitaxy (OMVPE) are used for growth. The following specific tasks are pursued: Develop an improved understanding of the role of the substrate and the growth parameters on the quality of device structures on GaAs and related materials grown by OMVPE. Investigate the frequency and power limits of power FET devices employing a two-dimensional electron gas in the channel. Produce semiconductor light emitters capable of high speed amplitude modulation. Investigate and improve heterojunction structures for transistor applications. Develop high speed receivers for optical communication using optical field effect transistors and large area epitaxial photoconductive detectors. Model and construct components and subsystems which can be useful as transmitters in optical communication systems. Improve direct method of broad band circuit design. Explore transient carrier transport in small III-V devices in boundary limited domain. GRA

N87-25000# Georgia Univ., Athens. Dept. of Chemistry.
CHEMICAL BONDING TOPOLOGY OF SUPERCONDUCTORS. 2. TERNARY LANTHANIDE RHODIUM BORDIES
R. B. King 6 Mar. 1987 13 p
(AD-A178079; TR-38) Avail: NTIS HC A02/MF A01 CSCL 07D

Graph theory derived methods are used to derive the chemical bonding topology of the closed shell Rhodium Boride building blocks of the superconducting lanthanide rhodium borides, Lanthanum Rhodium Boride (Ln = lanthanides such as Neodymium, Samarium, Erbium, Thulium, Lutetium). They are electronically linked in a three-dimensional lattice by exotetrahedral Rh-Rh bonds. This work thus provides an example of an additional class of relatively high temperature superconductors exhibiting porously delocalized chemical bonding topology like the Chevrel phases discussed in the previous paper of this series. GRA

N87-25001# Georgia Univ., Athens. Dept. of Chemistry.
CHEMICAL BONDING TOPOLOGY OF SUPERCONDUCTORS. 1. TERNARY MOLYBDENUM CHALCOGENIDES (CHEVREL PHASES)
R. B. King 6 Mar. 1987 25 p
(AD-A178277) Avail: NTIS HC A02/MF A01 CSCL 20C

Models for the chemical bonding topologies of ternary molybdenum chalcogenides (Chevrel phases) are derived using methods based on graph theory. The molybdenum sulfite Chevrel phases as well as their selenium analogs are viewed as three-dimensional lattices of edge-localized discrete molybdenum octahedra through face-sharing leads successively to the Mo9S11 napthalene analog and the Mo12S14 anathracene analog with increasing fusion leading to increasing delocalization of the chemical bonding topology within individual molybdenum cluster units. The infinite limit of such fusion of molybdenum octahedra corresponds to the infinite chain pseudo-one-dimensional metals which are formulated with globally delocalized octahedral cavities. GRA

N87-25002# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
FOCUSED ION BEAM FABRICATION OF GRADED CHANNEL FET's (FIELD EFFECT TRANSISTORS) IN GaAs AND Si Semiannual Technical Report, 1 Jul. - 31 Dec. 1986
John J. Melngailis Mar. 1987 10 p
(Contract MDA903-85-C-0215)
(AD-A178339) Avail: NTIS HC A02/MF A01 CSCL 09A

The aim of this program is to fabricate field effect transistors in Silicon and GaAs in which the doping in the channel is varied as a function of distance from source to drain. The focused ion beam machine is a unique tool which is capable of producing such graded implants. In achieving this goal alignment procedures of the focused ion beam to existing features on the wafer have to be developed, and the focused ion beam implants must be characterized and compared to conventional implants. In addition, models of the behavior of the graded channel devices must be developed. GRA

N87-25003# Arizona Univ., Tucson. Dept. of Chemistry.
POLY-PHENYLENE-QUINONEDIIMINE AS A POSSIBLE CONDUCTING LIQUID CRYSTAL Technical Report, 1 Jul. 1985 - 30 Jun. 1986
H. K. Hall 30 Jun. 1986 4 p
(Contract N00014-83-K-0376)
(AD-A178422; TR-5) Avail: NTIS HC A02/MF A01 CSCL 07C

The synthesis of stable electrically conducting, fabricable polymers of known structure represents an important goal of current polymer science. It seems to us that conductive, processable, and stable materials of defined structure should not be beyond the reach of the modern synthetic polymer chemist. Our approach has been to utilize a wide variety of polycondensation reactions to see whether they are useful for the synthesis of potentially conducting, stable, processable polymers. Polycondensation routes are preferred because they will lead to polymers of rational, known structure. Standard techniques of polymer chemistry such as copolymerization, use of unsymmetrical monomers, and introduction of softening substituents can be used to enhance processability. Further, the extended para structures preferred for conductivity may also lead to liquid crystal behavior, another potential tool for fabrication. GRA

N87-25004*# New Mexico Univ., Albuquerque. Dept. of Physics and Astronomy.
ANALYSIS OF BORON CARBIDES' ELECTRONIC STRUCTURE Final Technical Report, 18 Jul. 1984 - 17 Aug. 1986
Iris A. Howard and Charles L. Beckel 18 Aug. 1986 29 p Prepared for JPL
(Contracts NAS7-918; JPL-956970)
(NASA-CR-181082; JPL-9950-1312; NAS 1.26:181082; RE-156)
Avail: NTIS HC A03/MF A01 CSCL 20L

The electronic properties of boron-rich icosahedral clusters were studied as a means of understanding the electronic structure of the icosahedral borides such as boron carbide. A lower bound was estimated on bipolaron formation energies in B12 and B11C icosahedra, and the associated distortions. While the magnitude of the distortion associated with bipolaron formation is similar in both cases, the calculated formation energies differ greatly, formation being much more favorable on B11C icosahedra. The stable positions of a divalent atom relative to an icosahedral borane was also investigated, with the result that a stable energy minimum was found when the atom is at the center of the borane, internal to the B12 cage. If incorporation of dopant atoms into B12 cages in icosahedral boride solids is feasible, novel materials might result. In addition, the normal modes of a B12H12 cluster, of the C2B10 cage in para-carborane, and of a B12 icosahedron of reduced (D sub 3d) symmetry, such as is found in the icosahedral borides, were calculated. The nature of these vibrational modes will be important in determining, for instance, the character of the electron-lattice coupling in the borides, and in analyzing the lattice contribution to the thermal conductivity. Author

N87-25005# California Univ., Berkeley. Lawrence Berkeley Lab.
HYDROGEN-RELATED IMPURITY COMPLEXES IN GERMANIUM AND SILICON
E. E. Haller and L. M. Falicov Feb. 1987 28 p Presented at the 3rd Brazilian School of Semiconductor Physics, Campinas, Brazil, 16 Feb. 1987
(Contract DE-AC03-76SF-00098)
(DE87-008222; LBL-22976; CONF-870276-1) Avail: NTIS HC A03/MF A01

The properties of a number of hydrogen-related complexes in crystalline Ge and Si are reviewed. Hydrogen is shown to form electrically active as well as neutral complexes with native defects and impurities in germanium, silicon and several III-V compound semiconductors. Most of the electrically active centers form shallow levels in the bandgap. The complexes form when hydrogen binds to substitutional impurities such as C, O, Si, Be, Zn, Cu in the case of Ge. A shallow Be-H acceptor complex has been found in Si. The unusual electronic groundstate configurations of these complexes can be explained for some centers with a model involving tunneling hydrogen and for the rest of the centers with a triagonally distorted impurity complex. The structure and composition of several complexes has been determined using infrared piezospectroscopic techniques, substitution of hydrogen with deuterium or tritium, and crystal-growth-related impurity arguments. Hydrogen has been shown to fully passivate impurities leading to neutral complexes. Such centers are less well understood because they lack properties which could be observed with high sensitivty and resolution. Local vibrational mode spectroscopy may elucidate the structure of some neutral complexes. DOE

N87-25006# International Centre for Theoretical Physics, Trieste (Italy).
RESONANT ELECTRONIC RAMAN SCATTERING ON DONOR LEVELS IN CdTe
Ba An Nguyen and Van Hieu Nguyen May 1986 10 p

(DE87-701767; IC-86/85) Avail: NTIS (US Sales Only) HC A02/MF A01

A theoretical explanation is presented for the enhancement of the resonant impurity electronic Raman Scattering in CdTe with the transition of the electron from the donor ground state to the first excited one. If two exciton energy levels 1s and 2s are taken into account simultaneously, then the results of the calculations in the polariton theory are in good agreement with the experimental data. DOE

N87-25007# International Centre for Theoretical Physics, Trieste (Italy).

MAGNETIC PINNING INTERACTION OF A TYPE-2 SUPERCONDUCTING CYLINDER

A. G. Saif and L. N. Shehata Jun. 1986 18 p

(DE87-701774; IC-86/99) Avail: NTIS (US Sales Only) HC A02/MF A01

A model of the magnetic pinning interaction (i.e., a system of N-curved flux lines (FLs) and a cylindrical inclusion) has been developed. The field components inside and outside the inclusion have been calculated. The energy of the system and the magnetic pinning force are completely determined from the field distribution inside the superconductor. The properties of the curved FLs near the surface of a type-II superconducting cylinder have been established. The energy of the system as well as the magnetic field and the current density have been calculated. The force on a flux line (FL) element is completely determined by the total current density at the element position. DOE

N87-25008# International Centre for Theoretical Physics, Trieste (Italy).

EFFECTS OF THE SURFACE BARRIERS ON A CRITICAL STATE OF A TYPE-2 SUPERCONDUCTING SLAB

A. G. Saif Jun. 1986 12 p

(DE87-701775; IC-86/100) Avail: NTIS (US Sales Only) HC A02/MF A01

The structure of the surface barrier in a critical state model is investigated theoretically. This barrier disappears when the external field B(sub O) approaches a superheating field B(sub s). An expression for B(sub s) is found for the case of the absence of the transport current. The metastable of the flux lines (FLs) can appear at B(sub O)=B', the supercooling field. The supercooling and the superheating fields are dependent on the applied field angle and on the self-field generated by a transport current flowing through the slab. The magnetic fields distribution at a critical current of a type II superconducting slab are predicted. The value of the critical current is dependent on the applied field angle. DOE

N87-25009 Missouri Univ., Columbia.

EXPERIMENTS WITH NEUTRON SCHROEDINGER WAVES Ph.D. Thesis

Muhammad Arif 1986 188 p

Avail: Univ. Microfilms Order No. DA8701361

Four neutron Schroedinger wave interference experiments are described: (1) null Fizeau effect for thermal neutrons in thermal matter; (2) precision measurements of the energy dependent scattering length of U-235; (3) gravitationally induced quantum interference; and (4) investigation of incident beam coherence questions in dynamical diffraction experiments. In the Fizeau effect experiment it was verified that a neutron de Broglie wave is not affected by the state of motion of matter within fixed boundaries through which the neutron is propagating. Upper limits for the energy dependence of the neutron optical potential and the wavelength dependence of s-wave neutron scattering lengths were deduced. Using the neutron interferometric technique the energy dependent bound coherent scattering lengths of U-235 were directly measured in the energy range of 30 to 92 meV with an error of 0.3%. In the gravity induced quantum interference experiments (COW), the results showed that the observed loss of contrast of the interference pattern is caused in part by the bending of the perfect crystal neutron interferometer. Lastly, mathematical and numerical calculation techniques are presented to investigate the effect of wavefront modulation and transverse coherence of an incident neutron beam in dynamical diffraction experiments. Experimental and theoretical pendelloesung interference patterns in perfect silicon crystal were obtained and compared.

Dissert. Abstr.

N87-25010 Paris-Sud Univ., Orsay (France).

PHOTOEMISSION OF QUANTUM WELLS AND SUPERLATTICE GaAs/GaAlAs IN NEGATIVE ELECTRON AFINITY STATE Ph.D. Thesis [PHOTOEMISSION DE PUITS QUANTIQUES ET DE SUPERRESEAUX GAAS/GAALAS EN ETAT D'AFFINITE ELECTRONIQUE NEGATIVE]

Romuald Houdre 1985 159 p In FRENCH; ENGLISH summary

(ETN-87-99554) Avail: NTIS Issuing Activity

The luminiscence of quantum wells under circular polarized light excitation was studied. Experimental evidence of electron transport by tunneling from quantized states in a superlattice or a quantum well to a negative electron affinity state is found. The experimental curves show structures at the energies of the allowed optical transitions in agreement with the calculated and experimental luminiscence values. Preliminary results on energy analysis of electrons emitted from a super lattice are presented. The experiment shows the conduction band quantization into subbands in a superlattice and allows the direct measurement of the confinement energy of the first conduction subband. ESA

N87-25011 Paris-Sud Univ., Orsay (France).

ELECTRONIC TRANSPORT AND MAGNETISM IN IRRADIATED ORGANIC CONDUCTORS Ph.D. Thesis [TRANSPORT ELECTRONIQUE ET MAGNETISME DANS LES CONDUCTEURS ORGANIQUES IRRADIES]

Marc Sanquer 1985 176 p In FRENCH

(ETN-87-99555) Avail: NTIS Issuing Activity

The electronic transport and the magnetic properties of irradiated conductive organic crystals are discussed. The evolution of magnetic susceptibility with dose and temperature, and the distribution of conductive line width as a function of defect concentration were studied, particularly the compounds TTF-TCNQ and (TMTSF)2C104. It is shown that if the electrons are sufficiently one dimensional the instabilities are developed in the high temperature condition, and an electric current transport capability may appear. ESA

N87-25012# Max-Planck-Inst. fuer Festkoerperforschung, Stuttgart (West Germany).

ATOMISTIC ORIGINS OF WAFER DISTORTION Final Report, Sep. 1984

Hans Christian Alt, Hanns-Ulrich Habermeier, Leander Tapfer, Werner Frank, and Niko A. Stolwijk (Max-Planck-Inst. fuer Metallforschung, Stuttgart, West Germany) Bonn, West Germany BMFT Dec. 1986 112 p In GERMAN; ENGLISH summary Sponsored by BMFT

(BMFT-FB-T-86-086; ISSN-0340-7608; ETN-87-99695) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 23.50

The macroscopic and microscopic changes in silicon wafers induced by processing steps were surveyed using interferometric measurement of wafer distortion, X-ray diffractometry, X-ray topography, photoluminescence, and electron beam induced current. Modern processing technology yields a plastic distortion below 0.2 microns, elastic distortions produced by overlaps can be described quantitatively in terms of interface stresses. The influence of oxygen and nitrogen on the mechanical and electrical properties of Si was investigated. A nondestructive technique for the study of the formation and depth distribution of oxygen precipitates was developed. Nitrogen-correlated defects giving rise to work hardening were characterized using the photoluminescence technique. The diffusion and solubility of gold in silicon were determined using neutron activation analysis and spreading-resistance measurements. From these data the Si self-diffusivity was calculated. A technique for the visualization of defects in Si by decoration with Au was developed. ESA

N87-25013# Fraunhofer-Inst. fuer Angewandte Festkoerperphysik, Freiburg (West Germany).
IDENTIFICATION AND CHARACTERIZATION OF POINT DEFECTS IN GaAs AND InP Final Report, Jun. 1985
Martina Baeumler, Helmut Ennen, Ulrich Kaufmann, Harald Mueller, Gernot Pomrenke, Juergen Schneider, and Johannes Windscheif Bonn, West Germany BMFT Dec. 1986 44 p In GERMAN; ENGLISH summary Sponsored by BMFT
(BMFT-FB-T-86-111; ISSN-0340-7608; ETN-87-99699) Avail: NTIS HC A03/MF A01; Fachinformationsentrum, Karlsruhe, West Germany DM 9

Materials characterization of GaAs and InP was performed using electron spin resonance (ESR) and optical spectroscopy. The ESR investigation of as-grown semi-isolated (SI) GaAs provided evidence for the identity of the mid-gap donors EL2 and GaAs. A topographic method for the measurement of fluctuations in IR absorption nondestructively and quantitatively was developed for the homogeneity assessment of GaAs wafers. Three deep defects were discovered in SI GaAs; they are important for the compensation of the material but their chemical identity is still unknown. Using ion implantation and epitaxial techniques III-IV semiconductors were doped with 4f-ions. The photoluminescence properties of Yb, Er, and Nd in GaAs, InP, and GaI, as well as of Er in Si were determined. The characteristic emissions of Yb at 1.0 micron, and of Er at 1.54 micron were excited electrically in InP:Yb and Si:ER-pn-diodes. ESA

N87-25014# Stanford Univ., Calif. Dept. of Materials Science and Engineering.
FUNDAMENTAL STUDIES OF THE MECHANICAL BEHAVIOR OF MICROELECTRONIC THIN FILM MATERIALS Interim Scientific Report, 1 Nov. 1985 - 31 Oct. 1986
William D. Nix Mar. 1987 34 p
(Grant AF-AFOSR-0051-86)
(AD-A179704; AFOSR-87-0449TR) Avail: NTIS HC A03/MF A01 CSCL 09A

A fundamental program of research on the mechanical properties of microelectronic thin film material has been initiated at Stanford University. The work is being supported under AFOSR Grant No. 86-0051. In this interim Scientific Report, some of the progress made during the first year of the program is reviewed. We have made very rapid progress,expecially in the development of new experimental techniques for measuring mechanical properties. The work has already led to several publications and to an equal number of invited oral presentations, both of which are listed at the end of this report. The primary motivation of this work is to understand the mechanical properties of microelectronic this film materials. Although these materials are not structural materials as such, they are, nevertheless, expected to withstand very high stresses, both during manufacturing and in service. As a consequence, the mechanical properties of these materials are almost as important as their electronic properties for successful device applicaitions. because these materials often exist only as thin films bonded to substrates, it is necessary to study their mechanical properties in that state. GRA

N87-25015# Washington Univ., St. Louis, Mo. Semiconductor Research Lab.
CLUSTERING AND ORDERING IN III-V ALLOYS Final Report, 1 Jun. 1982 - 31 Dec. 1986
C. M. Wolfe, M. W. Muller, P. A. Fedders, G. A. Davis, and S. J. Hsieh 2 Mar. 1987 63 p
(Grant AF-AFOSR-0231-82)
(AD-A179767; WU/SRL-59583A-12; AFOSR-87-0400TR) Avail: NTIS HC A04/MF A01 CSCL 11F

ZnSnP2 is a potentially useful semiconductor which can have either the sphalerite structure or the chalcopyrite structure with no tetragonal distortion (c=2a). We have grown ZnSnP2 on various orientations of GaAs by liquid phase epitaxy and found that the best growth occurs on (110) surfaces. Double-crystal x-ray diffraction measurements indicate that these (110) layers have a lattice constant of 5.6507A, while (111) As layers grown under identical conditions have a lattice constant of 5.6532A, which matches GaAs to within + or - .0002A. GRA

N87-25016# Hughes Research Labs., Malibu, Calif.
NONLINEAR OPTICAL PROPERTIES AND SUBPICOSECOND DYNAMICS OF EXCITONS AND ELECTRON-HOLE PLASMAS IN MULTIPLE QUANTUM WELL STRUCTURES Progress Report, Aug. - Dec. 1986
A. L. Smirl, R. A. McFarlane, and J. F. Lam 26 Jan. 1987 13 p
(Contract F49620-84-C-0083)
(AD-A179855; HAC-REF-F4757(F706); AFOSR-87-0367TR)
Avail: NTIS HC A02/MF A01 CSCL 20L

Time resolved photoluminescence measurements are reported for Molecular Beam Epitaxially-grown AlxGa(1-x) As samples having alloy compositions which result in both direct gap and indirect gap materials. Quantitative results have been obtained for bandgap renormalization inducted at high carrier densities and the results compared with a theoretical model. Ultrafast spectroscopy measurements on an MBE grown x=0.52 sample following optical excitation well above the bandgap show presistent bleaching of the direct absorption, inducted absorption below the fundamental absorption edge and a blue shift by Fabry Perot fringes in the transparent spectral region. GRA

N87-25017*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BORON NITRIDE: COMPOSITION, OPTICAL PROPERTIES AND MECHANICAL BEHAVIOR
John J. Pouch, Samuel A. Alterovitz, Kazuhisa Miyoshi, and Joseph D. Warner Apr. 1987 9 p Presented at the Spring Meeting of the Materials Research Society, Anaheim, Calif., 21-25 Apr. 1987
(NASA-TM-89849; E-3514; NAS 1.15:89849) Avail: NTIS HC A02/MF A01 CSCL 20L

A low energy ion beam deposition technique was used to grow boron nitride films on quartz, germanium, silicon, gallium arsenide, and indium phosphate. The film structure was amorphous with evidence of a hexagonal phase. The peak boron concentration was 82 at %. The carbon and oxygen impurities were in the 5 to 8 at % range. Boron-nitrogen and boron-boron bonds were revealed by X-ray photoelectron spectroscopy. The index of refraction varied from 1.65 to 1.67 for films deposited on III-V compound semiconductors. The coefficient of friction for boron nitride in sliding contact with diamond was less than 0.1. The substrate was silicon. Author

N87-24962# Joint Publications Research Service, Arlington, Va.
THEOREM PROPOSED REGARDING P-NP PROBLEM
Jie Wang *In its* China Report: Science and Technology 2 Sep. 1986 p 60-62 Transl. into ENGLISH from Kexue Tongbao (Beijing, China), v. 30, no. 10, May 1985 p 792-793 (For primary document see N87-24959 18-70)
Avail: NTIS HC A06/MF A01

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N87-25018# Florida Univ., Gainesville.
THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF FLUCTUATION THERMODYNAMIC PROPERTIES OF LIQUID SOLUTIONS Technical Progres Report, 15 Apr. 1985 - 4 Apr. 1986
J. P. OConnell 23 Feb. 1987 2 p
(Contract DE-FG05-85ER-13362)
(DE87-007405; DOE/ER-13362/1) Avail: NTIS MF A01

Work has proceeded in the three areas of theory, correlation and experiment. The theoretical analyses have focussed on the statistical mechanical basis for the successful method for

correlating liquid-phase activity coefficients of complex mixtures called solution of groups where the system is viewed as a mixture of groups rather than molecules and binary parameters are catalogued for the relatively small number of groups that make up the many molecules of petrochemical processing interest. From a correlation point of view, we have established a unique and simple form for the partial molar volume at infinite dilution of strong salts (e.g., NaCl) in water for all pressures and temperatures up to 350 C. In experiment, we have performed an analysis of the use of Rayleigh light scattering as a technique for obtaining thermodynamic properties of liquid mixtures. DOE

N87-25019# Brookhaven National Lab., Upton, N. Y.
SEARCH FOR A NEW FORCE
P. Thieberger 1987 11 p Presented at the 12th Moriond Workshop: Searches for New and Exotic Phenomena, Les Arcs, France, 1 Jan. 1987
(Contract DE-AC02-76CH-00016)
(DE87-008450; BNL-39580; CONF-870164-2) Avail: NTIS HC A02/MF A01

Horizontal motions of a well-balanced hollow copper sphere floating and almost totally submerged in a well insulated and shielded tank filled with water at 4 C were measured in the vicinity of a large cliff. A motion was observed in a direction nearly perpendicular to, and directed away from, the face of the cliff. Conventional explanations for this effect have not been found. The observation is consistent with the existence of a weak, non-Newtonian, substance dependent, medium range force of a magnitude compatible with results deduced from gravity measurements as a function of depth in mines and with conclusions reached in a recent reanalysis of the Eoetvoes experiment. Further measurements with different elements and in different geometries will be required to establish definitely the existence, source, and description of such a new force. DOE

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N87-25039# Kaiserslautern Univ. (West Germany). Fachbereich Physik.
INTERACTIVE VIDEO FOR TEACHING SPACE SCIENCE
H.-J. Jodl *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 75-76 (For primary document see N87-25026 18-89)
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N87-25040# Kansas State Univ., Manhattan. Dept. of Physics.
INTERACTIVE VIDEO FOR TEACHING SPACE SCIENCE
Dean Zollman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 77-80 (For primary document see N87-25026 18-89)
(Grants NSF SER-81-63153; NSF SPE-82-63019)
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N87-25048# Open Univ., Oxford (England).
USE OF TV IN THE TEACHING OF ASTRONOMY AT THE OPEN UNIVERSITY
David A. Blackburn *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 137-140 (For primary document see N87-25026 18-89)
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N87-25049# Chalmers Univ. of Technology, Goeteborg (Sweden). Section of Astronomy.
PROMOTING SCIENCE THROUGH SCIENCE FICTION AND PSEUDOSCIENCE
Curt Roslund *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 141-144 (For primary document see N87-25026 18-89)
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N87-25050# Nicolaus Copernicus Univ., Torun (Poland). Inst. of Astronomy.
RECENT DEVELOPMENTS IN THE TEACHING OF ASTRONOMY
Cecylia Iwaniszewska *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 145-148 (For primary document see N87-25026 18-89)
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N87-25054# Saint Laurence's Primary School (England).
TEACHING ASTRONOMY IN THE PRIMARY SCHOOL
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N87-25055# Baunebjerskolen, Humlebaek (Denmark).
INTEGRATED SCIENCE, AGE 9-12
Kis Bonde *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 175-176 (For primary document see N87-25026 18-89)
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N87-25056# Baunebjerskolen, Humlebaek (Denmark).
INTEGRATED SCIENCE IN THE 4TH FORM (CHILDREN AGE 10)
Kis Bonde *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 177-178 (For primary document see N87-25026 18-89)
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N87-25060# Barcelona Univ. (Spain). Dept. de Fisica de la Terra i del Cosmos.
TEACHING ASTRONOMY IN CATALONIA (SPAIN): SOME EXPERIENCES IN PRIMARY AND SECONDARY SCHOOL
Robert Estallela, B. Sanahuja, G. Rossello, M. Asuncion Catala-Poch, and E. Buchaca *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 205-209 (For primary document see N87-25026 18-89)
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N87-25061# Rome Univ. (Italy). Dipt. di Matematica.
WEEKS OF ASTRONOMY IN THE COUNTRYSIDE
Nicoletta Lanciano *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 211-215 (For primary document see N87-25026 18-89)
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N87-25063# Hedeboskolen, Skagen (Denmark).
ASTRONOMY IN SECONDARY SCHOOLS
Harald Aaen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 225-227 (For primary document see N87-25026 18-89)
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N87-25064# Modena Univ. (Italy). Dept. of Physics.
TEACHING ASTRONOMY TO PUPILS AGED 11-13
Arturo Loria, M. Michelini, and Vittorio Mascellani *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 229-233 (For primary document see N87-25026 18-89)
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N87-25065# Turin Univ. (Italy). Ist. di Fisica Generale.
ASTRONOMY IN TEACHING PHYSICS IN SECONDARY HIGH SCHOOLS: A PROPOSAL FOR ITALY
Roberto Gallino *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 235-243 (For primary document see N87-25026 18-89)
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N87-25066# Poznan Technical Univ. (Poland). Inst. of Physics.
ASTRONOMY IN POLISH HIGH SCHOOL
Henryk Szydlowski *In* ESA Proceedings of the GIREP Conference

1986. Cosmos: An Educational Challenge Nov. 1986 p 245-248 (For primary document see N87-25026 18-89)
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N87-25067# Roskilde Univ. (Denmark).
THE PHYSICIST'S CONCEPT OF NATURE/THE UNIVERSE: RECENT DEVELOPMENTS IN SYLLABUS IN THE DANISH GYMNASIUM
Helge Kastrup *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 249-250 (For primary document see N87-25026 18-89)
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N87-25068# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Science Teaching.
ASTROPHYSICS IN HIGH SCHOOL: WHAT AND HOW?
Zvi Geller and Uri Ganiel *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 251-253 (For primary document see N87-25026 18-89)
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N87-25070# Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.
ASTRONOMY IN US HIGH SCHOOLS
Ph. M. Sadler *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 261-263 (For primary document see N87-25026 18-89)
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N87-25071# Attila (Jozsef) Univ., Szedged (Hungary). Inst. for Experimental Physics.
TEACHING OF ASTRONOMY IN HUNGARIAN GRAMMAR SCHOOLS
Csaba Kalamar, Karoly Szatmary, and E. Toth *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 265-268 (For primary document see N87-25026 18-89)
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N87-25072# Pedagogical Faculty, Ostravia (Czechoslovakia). Dept. of Physics.
THE DEVELOPMENT AND THE STRUCTURE OF MATTER
Erika Mechlova *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 269-275 (For primary document see N87-25026 18-89)
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N87-25073# Futures' Museum, Falun (Sweden).
TWENTY-SEVEN STEPS TOWARD THE UNIVERSE: EXPERIMENTAL ASTRONOMY TEACHING IN PRIMARY AND SECONDARY SCHOOLS
Lars Broman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 281-283 (For primary document see N87-25026 18-89)
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N87-25074# Perugia Univ. (Italy). Dipt. di Fisica.
TEACHING ON METEORITES
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N87-25075# Observatoire de Marseille (France).
THE TRAINING IN ASTRONOMY OF FRENCH PRIMARY AND SECONDARY SCHOOL TEACHERS
Marie-France Duval and G. Walusinski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 293-295 (For primary document see N87-25026 18-89)
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N87-25076# Porto Univ. (Portugal). Grupo de Matematica Aplicada.
TEACHING OF ASTRONOMY AT UNIVERSITY LEVEL IN PORTUGAL
Maria Teresa Vaz Tor Lago *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 297-298 Sponsored by the American Astronomical Society Henri Chretien Award (For primary document see N87-25026 18-89)
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N87-25077# Osservatorio Astrofisico di Arcetri, Florence (Italy).
DIDACTIC ACTIVITIES OF THE ITALIAN ASTRONOMICAL SOCIETY (IAS)
Maria E. D. Pestellini *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 299-301 (For primary document see N87-25026 18-89)
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N87-25079# Utrecht State Univ. (Netherlands).
CAPRA IN THE CLASSROOM?
Piet L. Lijnse *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 311-312 (For primary document see N87-25026 18-89)
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N87-25081# Copenhagen Univ. (Denmark). Astronomy Observatory.
PUBLIC UNIVERSITY COURSES IN ASTRONOMY
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N87-25082# Istituto Tecnico Industriale (Stanislao Cannizzaro), Milan (Italy).
ASTRONOMY AND COSMOS: CONCEPTS AND MISCONCEPTS IN COMMUNICATING SCIENCE
Ludovica Manusardi Carlesi *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 325-326 (For primary document see N87-25026 18-89)
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N87-25083# Sofia Univ. (Bulgaria).
STUDY OF HISTORY OF CULTURE BY TEACHING HISTORY OF ASTRONOMY
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N87-25086# Consiglio Nazionale delle Ricerche, Turin (Italy). Gruppo Nazionale di Didattica della Fisica.
AIMS AND DIFFICULTIES IN TEACHING HISTORY OF ASTRONOMY IN PHYSICAL COURSES: 10 YEARS' EXPERIENCE
Lidia Nuvoli *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 341-343 (For primary document see N87-25026 18-89)
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N87-25087# Kaiserslautern Univ. (West Germany). Fachbereich Physik.
VIDEOFILMS OF SPACELAB MISSIONS IN COMBINATION WITH REAL EXPERIMENTS AND COMPUTER SIMULATION
H.-J. Jodl and U. Sader *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 347-348 (For primary document see N87-25026 18-89)
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N87-25088# Rockwell Shuttle Operations Co., Houston, Tex.
INTERACTIVE SPACE EDUCATION AND SPACE SHUTTLE MISSION 51-L
P. D. Maley *In* ESA Proceedings of the GIREP Conference

1986. Cosmos: An Educational Challenge Nov. 1986 p 349-351 (For primary document see N87-25026 18-89)
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N87-25089# Danish Space Research Inst., Lyngby.
THE EXPLORATION OF THE SOLAR SYSTEM AS AN EVERYDAY ACTIVITY
Ib Lundgaard Rasmussen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 353-354 Sponsored by the Danish Film Board, and the Egmont H. Petersens Foundation (For primary document see N87-25026 18-89)
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N87-25091# Western Australian Inst. of Tech., Perth. Science and Mathematics Education Center.
SECONDARY STUDENTS' UNDERSTANDING OF THE SOLAR SYSTEM: IMPLICATION FOR CURRICULUM REVISION
David Franklin Treagust and C. L. Smith *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 363-368 (For primary document see N87-25026 18-89)
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N87-25092# IRRSAE Piemonte, Torino (Italy).
EARTH, SKY AND MOTION. SOME QUESTIONS TO IDENTIFY PUPILS' IDEAS
Maria Luisa Viglietta *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 369-37 (For primary document see N87-25026 18-89)
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N87-25093# Wyzsza Szkola Pedagogiczna, Cracow (Poland). Inst. of Physics.
TEACHING RELATIVITY OF MOTION IN PRIMARY SCHOOL AS A FIRST STEP FOR UNDERSTANDING COSMOLOGY, MODERN PHYSICS, AND ASTRONOMY
Jerzy Ogar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 371-373 (For primary document see N87-25026 18-89)
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N87-25094# Wyzsza Szkola Pedagogiczna, Cracow (Poland). Inst. of Physics.
IDEAS ABOUT PHYSICAL PHENOMENA IN SPACESHIPS AMONG STUDENTS AND PUPILS
Jerzy Ogar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 375-378 (For primary document see N87-25026 18-89)
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N87-25095# Poznan Technical Univ. (Poland). Inst. of Physics.
SCIENCE FICTION IN TEACHING ASTRONOMY AND PHYSICS
A. Rolewicz and Henryk Szydlowski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 379-381 (For primary document see N87-25026 18-89)
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N87-25096# Roskilde Univ. (Denmark).
SCIENCE FICTION AND TEACHING PHYSICS
Helge Kastrup *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 383-385 (For primary document see N87-25026 18-89)
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N87-25097# Western Australian Coll. of Advanced Education, Perth. Dept. of Science.
LEARNING AND THE ACQUISITION OF A KNOWLEDGE STRUCTURE FOR THE DISCIPLINE OF ASTRONOMY
C. L. Smith and David Franklin Treagust *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 387-390 (For primary document see N87-25026 18-89)
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N87-25101# Dunsink Observatory, Dublin (Ireland).
A SPECIFICATION FOR AN INTERACTIVE VIDEO TUTOR
Ian Elliott *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 403-406 (For primary document see N87-25026 18-89)
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81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N87-25020# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany).
[ACTIVITIES REPORT IN AEROSPACE RESEARCH] Annual Report, 1985
Aug. 1986 124 p In GERMAN; ENGLISH summary Original contains color illustrations
(ISSN-0070-3966; ETN-87-99677) Avail: NTIS HC A06/MF A01

An air traffic integrated navigation, communication, and air space surveillance system based on a distance measuring system was developed. A laser gyroscope; a hybrid composite material for fatigue-critical aircraft components; and a propfan turbine engine were studied. The heliostat and receiver measuring system HERMES was designed. The satellite communication and localization NAVEX experiment in the D1 Spacelab mission is described. An image processing system for remote sensing applications is examined. A 1kW CO2 laser with RF excitation was developed for materials processing. ESA

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N87-25021# Lawrence Livermore National Lab., Calif.
PRODUCTIVITY ASSESSMENT OF AN INTEGRATED VOICE/DATA WORKSTATION
W. W. Banks and P. G. Prassinos Mar. 1987 56 p
(Contract W-7405-eng-48)
(DE87-009098; UCID-21028) Avail: NTIS HC A04/MF A01

More than 500 management information systems are used by the Air Force Logistics Command (AFLC) to help keep the US Air Force's aerospace weapon systems in combat-readiness throughout the world. To accomplish its logistics mission, the AFLC helps manage and track $113 billion in assets and some 460,000 annual contracts. Major assets include 915,835 different supply items and the maintenance of 9418 aircraft. A staff of 102,600 in the AFLC handles these assets through four primary functions: Procurement, Material Management, Distribution, and Maintenance. Most of the information systems used in the massive logistics effort were designed 20 years ago for a batch-processing environment. To take advantage of new developments in automated office systems, the AFLC has established a Logistics Management System (LMS) modernization plan under which the AFLC will update and automate its functional processes, ADP hardware, software, and communication networks. As part of the program, the AFLC is studying what changes occur in human productivity through the use of an automated office information system that integrates voice and data. This report presents the results of the productivity study associated with implementation of an integrated voice and data system. These results will provide AFLC decision-makers with

sample estimates of productivity improvements that may be expected in an advanced integrated voice and data system. DOE

N87-25022# Department of Energy, Oak Ridge, Tenn.
RESOURCE DIRECTORY OF DOE INFORMATION ORGANIZATIONS
M. Jared, ed. Jan. 1987 191 p
(DE87-003393; DOE/TIC-4616-Rev-3) Avail: NTIS HC A09/MF A01

This Directory is the 1987 update of DOE/TIC-4616. It is a guide to information components of the Department of Energy (DOE) and is arranged by organization. When applicable, individual offices are listed hierarchically. Organization and personal name indexes are included. DOE

N87-25023* National Aeronautics and Space Administration, Washington, D.C.
NASA PATENT ABSTRACTS BIBLIOGRAPHY: A CONTINUING BIBLIOGRAPHY. SECTION 1: ABSTRACTS (SUPPLEMENT 31)
Jul. 1987 45 p
(NASA-SP-7039(31); NAS 1.21:7039(31)) Avail: NTIS HC A03; NTIS standing order as PB86-911100, $11.50 domestic, $23.00 foreign CSCL 05B

Abstracts are provided for 85 patents and patent applications entered into the NASA scientific and technical information system during the period January 1987 through June 1987. Each entry consists of a citation, an abstract, and in most cases, a key illustration selected from the patent or patent application. Author

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

N87-25024# Committee on Science, Space and Technology (U.S. House).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, FISCAL YEAR 1988
Washington GPO 1987 270 p Report on H.R. 2782 presented by the Committee on Science, Space and Technology to the Committee of the Whole House on the State of the Union, 100th Congress, 1st Session, 7 Jul. 1987
(H-Rept-100-204; GPO-69-356) Avail: NTIS HC A12/MF A01

Appropriations to the National Aeronautics and Space Administration (NASA) are reviewed for research and development; space flight, control, and data communications; construction of facilities, and research and development management. B.G.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

N87-25025# Technische Univ., Berlin (West Germany). Inst. fuer Luft- und Raumfahrt.
COMPARISON BETWEEN ALTERNATIVE CONCEPTS FOR LONG RANGE LUNAR SURFACE TRANSPORTATION [VERGLEICH ALTERNATIVER KONZEPTE FUER DEN FERNTRANSPORT AUF DER MONDOBERFLAECHE]
Uwe Apel, Sven Abitzsch, Buelent Alkan, Thomas Eckardt, Fabian Eilingsfeld, Lutz vonEntress-Fuersteneck, Ercan Goekcen, Andreas Groezinger, Dirke Hilberg,, Andreas Jain et al. Nov. 1986 110 p In GERMAN; ENGLISH summary
(ILR-Mitt-169; ETN-87-99673) Avail: NTIS HC A06/MF A01

Five lunar transportation systems based on four different conveyors were designed. The systems were compared on the basis of a cost-benefit analysis for a life cycle of 60 yr. results show that rockets consuming fuels produced on the Moon are best for long range lunar surface transportation, considering low to medium transportation demands. ESA

88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N87-25026# European Space Agency, Paris (France).
PROCEEDINGS OF THE GIREP CONFERENCE 1986. COSMOS: AN EDUCATIONAL CHALLENGE
Jim J. Hunt, ed. Nov. 1986 459 p Proceedings held in Copenhagen, Denmark, 18-23 Aug. 1986; sponsored by ESA, UNESCO, the Danish Ministry of Education, the Danish Natural Science Research Council, the Egmont H. Petersens Foundation, and the Royal Danish School of Educational Studies
(ESA-SP-253; ISSN-079-6566; ETN-87-99433) Copyright Avail: NTIS HC A20/MF A01

The reason for this conference is the improvement of education in physics and education through physics. Some topics discussed are: Educational use of space laboratories; teaching astronomy in primary school and high school; university astronomy; adult education and astronomy courses for the general public; and the history of astronomy in school curriculum. Educational use of films and other visual aids; and students' concepts of phenomena in the cosmos and in science fiction were also discussed. For individual titles, see N87-25027 through N87-25102.

N87-25027# Eotvos Lorand Univ., Budapest (Hungary). Dept. of Atomic Physics.
COSMOS AND PEOPLE **c70**
George Marx *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 7-11
(For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The origins of science and the construction of the Periodic Table are two of the topics discussed in this presentation. Other topics covered in detail are the origins of life on Earth, and its

evolution, and the role of astronomy teaching in high school.
ESA

N87-25028# Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics.
PHYSICS IN SPACE: THE EXAMPLE OF THE VEGA MISSION **c12**
Karoly Szegoe *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 13-20 (For primary document see N87-25026 18-89)
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The Vega mission is used to show how experiments are performed in space. The scientific objectives of the mission were to continue the investigation of Venus atmosphere and surface with a landing probe; to float a balloon in the Venus atmosphere (this was the first time a balloon was used outside Earth) to study circulation; and to fly by comet Halley. ESA

N87-25029# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Space Science Dept.
MAIN ACHIEVEMENTS AND FUTURE PLANS IN ESA'S PROGRAM **c12**
Arne Pedersen *In its* Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 21-24 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The achievements of the ESA space science program in traditional space science disciplines such as space plasma physics, astronomy, and planetary research are outlined. The future science programs, and the science elements in the Earth observation, meteorology, and microgravity programs are described. ESA

N87-25030# National Aeronautics and Space Administration, Washington, D.C.
EXPLORATION OF THE SOLAR SYSTEM: ACHIEVEMENTS AND FUTURE PLANS IN NASA'S PROGRAMME **c12**
William E. Brunk *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 25-29 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The Voyager 2 encounter with Uranus, ground-based and spacecraft observations of Comet Halley, and other NASA solar system exploration is reviewed. The Challenger tragedy significantly delayed the next NASA planetary mission, Galileo, as well as the Ulysses and the Space Telescope missions, all of which will provide data vital to understanding of the solar system. However, the results anticipated from these missions, as well as those from the 1989 Voyager encounter with Neptune and from other approved and planned planetary missions promise that NASA's future role in solar system exploration will remain alive and vital. ESA

N87-25031# Consiglio Nazionale delle Ricerche, Rome (Italy). Piano Spaziale Nazionale.
THE COLUMBUS PROGRAM **c18**
Alberto Loria *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 31-36 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The Columbus permanently manned space station project is outlined. In its first stage Columbus will have tight links with the International Space Station, the assembly of which is planned to start in 1993. Columbus should then develop into an autonomous European space station. The flight elements under negotiation with NASA with necessary ground infrastructures are described. Plans for the utilization of the system are summarized. ESA

N87-25032# Kansas State Univ., Manhattan. Dept. of Physics.
SKYLAB PHYSICS: LESSONS FOR 12-14 YEAR OLD PUPILS **c70**
Dean Zollman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 37-41 (For primary document see N87-25026 18-89)
(Grant NSF SED-79-18986)
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The spacious environment of Skylab enabled astronauts to demonstrate the laws of motion in a manner which cannot be repeated in the smaller quarters of Spacelab. Films were recorded during the Skylab mission, and a set of learning modules were designed for students who are 12 to 14 yr old (middle school or junior high school in the United States). The students complete experiments in the classroom and compare their results with similar situations which are displayed in the Skylab films. Thus, students are able to see how motion in an orbiting space station differs from similar motion on Earth. ESA

N87-25033# Open Univ., Oxford (England).
IDEAS FOR EDUCATIONAL PHYSICS EXPERIMENTS IN SPACE **c70**
David A. Blackburn *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 43-46 (For primary document see N87-25026 18-89)
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Spaceborne demonstrations dealing with centers of mass, convection, conservation of angular and linear momentum, and quantitative experiments concerning fluid motion, Keplerian orbits, and human body movements are suggested. Possible student groups (from astronauts to the general public) are indicated.
ESA

N87-25034# Glasgow Univ. (Scotland). Dept. of Physics and Astronomy.
THE LAMPS OF ATLANTIS: AN ASTRONOMICAL DETECTIVE STORY
Archie E. Roy *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 47-49 (For primary document see N87-25026 18-89)
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The origin of the stellar constellations familiar to western astronomers from ancient times is discussed using astronomical, literary, and archaeological evidence. The precession of the equinoxes, the zone of avoidance and the orientation of the constellations, and early Greek and Minoan astronomy are considered. ESA

N87-25035# University Coll., London (England). Dept. of Physics and Astronomy.
THE BIRTH OF STARS **c90**
D. McNally *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 51-55 (For primary document see N87-25026 18-89)
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The need for a theory of star formation is examined by means of a timescale argument. The relationship of star formation and interstellar material is described. Simple dynamics in star formation theory are used to illustrate the principle of collapse under gravity and to examine one of the difficulties encountered by such a mechanism. It is shown how simple physical arguments can be used to probe the validity of an apparently complicated and sophisticated theory. It is concluded that star formation theory, despite apparent complexity and sophistication, remains in a rudimentary state. ESA

N87-25036# Glasgow Univ. (Scotland).
ASTRONOMICAL PRACTICAL WORK IN HIGHER EDUCATION
David Clarke *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 57-62 (For primary document see N87-25026 18-89)
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The purpose of practical work, its organization, and the presentation of teaching experiments in higher education, particularly for science-based astronomy courses are discussed. The problems of what should now be taught in view of the recent advances in the subject are considered. The roles of computers and simulators in teaching schemes are reviewed. The practical

course at Glasgow University (Scotland) is presented with descriptions of exercises/experiments/projects. ESA

N87-25037# Edinburgh Univ. (Scotland). Dept. of Astronomy.
PHOTOGRAPHIC TEACHING PACKAGES IN ASTRONOMY
M. T. Brueck *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 63-70 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Exercises in astronomy and astrophysics for university students which use film copies of photographs taken with the 1.2m UK Schmidt Telescope are described. The Solar System, galactic objects, extragalactic objects, and objective prism spectra are covered. ESA

N87-25038# Royal Observatory, Edinburgh (Scotland).
EDUCATIONAL PACKAGES FOR SCHOOLS AND AMATEUR GROUPS
Susan Barbara Tritton *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 71-74 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Teaching packages available using film copies of original UK Schmidt Telescope photographs are described. There are 5 different packages, each containing 10 films and each package includes a selection of solar system, galactic, and extragalactic objects. Each package has a small accompanying booklet which gives details about the more interesting objects which can be found on each film. There are suggestions for exercises which could be done, such as galaxy classification, star counting, and discovering asteroids, but no specific exercises are included although some of the films are suitable as additional material for the undergraduate teaching packages. ESA

N87-25039# Kaiserslautern Univ. (West Germany). Fachbereich Physik.
INTERACTIVE VIDEO FOR TEACHING SPACE SCIENCE c80
H.-J. Jodl *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 75-76 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Uses of slides, video-films, computer programs and computer aided videos in science teaching for motivation; for demonstration of real phenomena; for the possibility to make rough estimations of processes; for taking real data; for presentation of complicated phenomena; for combination of different media; for producing films of low cost and in a manner in which interactivity is possible are described. ESA

N87-25040# Kansas State Univ., Manhattan. Dept. of Physics.
INTERACTIVE VIDEO FOR TEACHING SPACE SCIENCE c80
Dean Zollman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 77-80 (For primary document see N87-25026 18-89)
(Grants NSF SER-81-63153; NSF SPE-82-63019)
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Use of the random-access videodisk in the teaching of astronomy and space science is discussed. The ability to show any one of a large number of photos with a few simple key strokes offers great flexibility in teaching astronomy. If a student or planetarium visitor asks a question, the teacher can illustrate the response by rapidly selecting the appropriate visuals from a very large collection. Thus, planetarium programs and classroom discussions which use a visual display can be much more responsive to students' questions than presentations using traditional slides. Videodisks can also be used as part of an interactive lesson which the students control directly. The students can collect data on experiments, or they can explore planets by selecting individual pictures from a collection. ESA

N87-25041# Tata Inst. of Fundamental Research, Bombay (India).
THE LIGHTER SIDE OF GRAVITY c90
J. V. Narlikar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 81-85 (For primary document see N87-25026 18-89)
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Newton's and Einstein's descriptions of gravity are compared and contrasted with the examples of a terrestrial projectile and the black hole. The role of black holes is described in astrophysical contexts. ESA

N87-25042# Jerusalem Coll. for Women, Bayit Vegan (Israel).
STUDENTS' PERCEPTION OF ASTRONOMICAL CONCEPTS
Joseph Nussbaum *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 87-97 (For primary document see N87-25026 18-89)
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Examples of childrens' misconceptions in astronomy are described, and the sources are traced back to the elements of naive preconceptions. Misconceptions concern the shape of the Earth, the role of gravity, and the Earth as a cosmological body. ESA

N87-25043# Futures' Museum, Falun (Sweden).
ON THE TEACHING OF ASTRONOMY IN A PLANETARIUM
Lars Broman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 99-10 (For primary document see N87-25026 18-89)
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The general features of the planetarium and the kind of equipment that is used are described. Different kinds of educational and other astronomic planetarium shows are discussed. ESA

N87-25044# Tromsoe Univ. (Norway). Inst. of Mathematical and Physical Sciences.
THE CONNECTION BETWEEN THE EARTH AND THE UNIVERSE - MADE VISIBLE BY THE NORTHERN LIGHT c90
Jan-Erik Solheim *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 103-111 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Observation of the Aurora Borealis is reviewed. Mythological and scientific theories of its origins are summarized. ESA

N87-25045# Aarhus Univ. (Denmark). Dept. of History of Science.
TYCHO BRAHE: NOBLE ASTRONOMER WITH ROYAL SUPPORT
Kristian P. Moesgaard *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 113-12 (For primary document see N87-25026 18-89)
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The life and work of Tycho Brahe are described, including his astronomical instruments. ESA

N87-25046# Royal Danish School of Educational Studies, Copenhagen. Inst. of Physics.
OLE ROMER: A SHORT LIFE STORY OF A DANISH ASTRONOMER
August Ziggelaar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 121-128 (For primary document see N87-25026 18-89)
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Ole Romer (1644-1710) was the first to prove that light propagates at finite speed. He constructed planetariums, a micrometer, a grid telescope, a double view telescope, and thermometers. With his transit circle he measured very exact stellar positions. He was also prefect of police in Copenhagen. ESA

N87-25047# Copenhagen Univ. (Denmark). Astronomy Observatory.
COSMOLOGY c90
Kjeld Gyldenkerne *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 129-136 (For primary document see N87-25026 18-89)
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The conditions in the very early Universe following the Planck time at 10 to the minus 43rd power sec after Big Bang up to the recombination phase at 100,000 yr are described in the light of modern theories of elementary particle physics. Problems arising in the pure Big Bang theory may be solved, if an inflationary phase occurred just after the Grand Unification epoch at 10 to the minus 34th power sec. The observed Universe shows large structures of galaxy clusters, superclusters and voids of the order of 50 to 100 Mpc in dimensions, and views of how these structures were created are considered. The question of the dark matter and whether the Universe is closed or not is discussed. ESA

N87-25048# Open Univ., Oxford (England).
USE OF TV IN THE TEACHING OF ASTRONOMY AT THE OPEN UNIVERSITY **c80**
David A. Blackburn *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 137-140 (For primary document see N87-25026 18-89)
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Two series of TV programs were produced as part of a further education university course for students in full-time employment. Matter in the Universe is a middle level course. Topics treated include: observations of the interstellar medium; physics and chemistry of the interstellar medium; observations of stars; formation and evolution of stars; galaxies; solar system; and origin and evolution of planetary systems. Understanding Space and Time is a final level course. Topics considered in it include: Newtonian ideas in space and time; electromagnetism and special relativity; gravitation and general relativity; cosmology. ESA

N87-25049# Chalmers Univ. of Technology, Goeteborg (Sweden). Section of Astronomy.
PROMOTING SCIENCE THROUGH SCIENCE FICTION AND PSEUDOSCIENCE **c80**
Curt Roslund *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 141-144 (For primary document see N87-25026 18-89)
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Science fiction novels rich in scientific detail and with interesting applications of physics; books explaining the physics of science fiction; and books debunking pseudo-scientific theories about alien space ships are discussed. ESA

N87-25050# Nicolaus Copernicus Univ., Torun (Poland). Inst. of Astronomy.
RECENT DEVELOPMENTS IN THE TEACHING OF ASTRONOMY **c80**
Cecylia Iwaniszewska *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 145-148 (For primary document see N87-25026 18-89)
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It is proposed that the educational interest in astronomy be divided into the following categories: The introduction of first astronomical notions when teaching in schools at various levels; training teachers and young astronomers; preparing educational material; and education provided by planetaria and science museums. How these topics relate to the reality of teaching of astronomy is detailed. ESA

N87-25051# Glasgow Univ. (Scotland). Dept. of Physics and Astronomy.
THE IMPACT OF THE COSMOS ON THE HUMAN RACE **c53**
Archie E. Roy *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 149-151 (For primary document see N87-25026 18-89)
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It is suggested that throughout its history, the development of the human race, physically, mentally and spiritually, is shaped by the cosmos, never more so than at the present time when it engages in a search for extraterrestrial intelligence. ESA

N87-25052# New York State Dept. of Education, Albany. Bureau of Science Education.
PRACTICAL APPLICATIONS OF BASIC PHYSICS IN SPACE EXPLORATION **c70**
S. A. Agruso and John D. FitzGibbons *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 155-158 (For primary document see N87-25026 18-89)
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The role of the space exploration programs of the past 25 yr in introductory physics at the secondary level is discussed. The basic mechanics of space flight, the construction of a space station using the Shuttle, and programs planned for the future, such as the Hubble Space Telescope, are presented. Exercises based on video tapes of launches and landings are described. A list of source material for teachers is included. ESA

N87-25053# Technische Univ., Munich (West Germany). Sektion physik.
SUGGESTION FOR A DEMONSTRATION IN SPACELAB: PLANETARY MOTION BY COULOMB FORCE **c70**
Karl Luchner *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 159-161 (For primary document see N87-25026 18-89)
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A school physics demonstration experiment to be performed in Spacelab is described. The compensation of gravity is used to demonstrate the orbits of two bodies interacting by the Coulomb-force. In the demonstration experiment the Coulomb-force acts in the same way as gravitation acts in the real planetary system: two small bodies, properly electrically charged, orbit each other in the same way as planet and Sun, obeying Keplers laws. Equivalent demonstrations to be performed in a terrestrial laboratory are not possible. ESA

N87-25054# Saint Laurence's Primary School (England).
TEACHING ASTRONOMY IN THE PRIMARY SCHOOL **c80**
P. J. Pennington *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 165-174 (For primary document see N87-25026 18-89)
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It is argued that teaching astronomy in primary school is useful, apart from its intrinsic interest, since it can help develop an understanding and familiarity with scientific methods of enquiry, also the use of libraries and other reference materials. These information gathering skills are likely to prove invaluable as the pace of technical, scientific, and social change gains momentum. An annotated bibliography and teaching aids are presented. ESA

N87-25055# Baunebjerskolen, Humlebaek (Denmark).
INTEGRATED SCIENCE, AGE 9-12 **c80**
Kis Bonde *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 175-176 (For primary document see N87-25026 18-89)
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It is argued that physics and chemistry should be taught at an early age integrated with biology, nature, geography, astronomy etc. Teachers should go out in nature itself, or do small experiments in the classroom to meet the children's curiosity and stimulate it. Concrete operations and reasoning at an early age promote better formal and abstract thinking later on. Traditional physics mainly express male relationship with nature. Females often relate to nature in another way, which should be included in science not only to gain knowledge, but more insight and wisdom. ESA

N87-25056# Baunebjerskolen, Humlebaek (Denmark).
INTEGRATED SCIENCE IN THE 4TH FORM (CHILDREN AGE 10) **c80**
Kis Bonde *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 177-178 (For primary document see N87-25026 18-89)
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A series of 10 astronomy lessons taught to 10 yr olds in connection with Halley's comet is described. They covered cosmology, distances, constellations, and rocketry. ESA

N87-25057# Kyoto Municipal Science Center for Youth (Japan).
TEACHING ASTRONOMY BY USE OF A PLANETARIUM
Hiromichi Kataoka *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 179-18 (For primary document see N87-25026 18-89)
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A planetarium dome was used as a teaching tool to complement the study of astronomy in schools. A lesson guidance plan of 60-min on the motion of the Sun and stars, for the 5th grade pupils is described. Aspects which are essential to make the study in the dome possible as a class are shown. The previous knowledge of pupils and reformation of it are reviewed. ESA

N87-25058# Technical Univ. of Cracow (Poland). Inst. of Physics.
COSMOLOGY IN INTRODUCTORY COURSES OF SCIENCE - MISSED OPPORTUNITY **c90**
Zofia Golab-Meyer *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 185-190 (For primary document see N87-25026 18-89)
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Missed opportunities in teaching preparatory/introductory science courses are highlighted. These courses are usually (if at all) taught to children aged 7-14 who are still at the concrete reasoning developmental level. But this period of life is also characterized by a tremendous curiosity towards the surrounding world and a practically unlimited phantasy and ability to deal with imaginary beings. In this period very fundamental questions, often of a philosophical nature are asked, and should be taken into account when teaching an introductory science course. The course is important since it usually coincides with mnemosyne age and knowledge acquired in that period is very well stored. ESA

N87-25059# Municipal Inst. of Education, Barcelona (Spain).
THE PLANETARIUM IN THE INTEGRATED LEARNING OF COSMOGRAHY FROM THE INITIAL CYCLE IN PRIMARY SCHOOL **c90**
Laura VanMessem *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 191-204 (For primary document see N87-25026 18-89)
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A program of cosmography in accordance with the official curriculum of the Spanish kindergarten and primary school is proposed. ESA

N87-25060# Barcelona Univ. (Spain). Dept. de Fisica de la Terra i del Cosmos.
TEACHING ASTRONOMY IN CATALONIA (SPAIN): SOME EXPERIENCES IN PRIMARY AND SECONDARY SCHOOL **c80**
Robert Estallela, B. Sanahuja, G. Rossello, M. Asuncion Catala-Poch, and E. Buchaca *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 205-209 (For primary document see N87-25026 18-89)
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A methodological approach to astronomy teaching based on experiments that can be carried out with inexpensive instruments was developed. At primary school, the Sun, the Moon, and the Solar System are introduced. An approach to teaching equatorial coordinates and the Hertzsprung-Russell diagram is outlined. ESA

N87-25061# Rome Univ. (Italy). Dipt. di Matematica.
WEEKS OF ASTRONOMY IN THE COUNTRYSIDE **c80**
Nicoletta Lanciano *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 211-215 (For primary document see N87-25026 18-89)
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Astronomy programs for 6 to 8 yr old students taught outdoors at a country house are described. It is proposed that a direct contact with the objects of nature, on the earth and in the sky, observed in their real time is effective. It is hoped that direct observation can help to establish a link between thinking and seeing like a scientist, which are typical problems in teaching astronomy. ESA

N87-25062# Ljubljana Univ. (Yugoslavia). Dept. of Physics.
HOW TO INCORPORATE ASTRONOMY INTO PHYSICS?
J. Strnad *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 221-223 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

It is argued that astronomy should be incorporated into high school physics teaching, but as units which maintain a specifically astronomical nature. Units are suggested. ESA

N87-25063# Hedeboskolen, Skagen (Denmark).
ASTRONOMY IN SECONDARY SCHOOLS **c80**
Harald Aaen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 225-227 (For primary document see N87-25026 18-89)
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A Danish project, where astronomy, physics, mathematics and computer science are put together in a single subject is outlined. The project also includes English and German at a higher level. ESA

N87-25064# Modena Univ. (Italy). Dept. of Physics.
TEACHING ASTRONOMY TO PUPILS AGED 11-13 **c80**
Arturo Loria, M. Michelini, and Vittorio Mascellani *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 229-233 (For primary document see N87-25026 18-89)
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A project for the teaching of astronomy was developed. The content is the Solar System, but a wide interdisciplinarity can be realized. Particular care is devoted to a personal multiform activity by the pupils, alone and in groups. They use conventional apparatus, but also built some themselves. Graphic work is devoted to orbits, and practical work to the construction of scale models, and to the representation of the surface of heavenly bodies. The mentality of young people emerges fundamentally matured from such an experience. ESA

N87-25065# Turin Univ. (Italy). Ist. di Fisica Generale.
ASTRONOMY IN TEACHING PHYSICS IN SECONDARY HIGH SCHOOLS: A PROPOSAL FOR ITALY **c80**
Roberto Gallino *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 235-243 (For primary document see N87-25026 18-89)
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Astronomy teaching in secondary high schools in Italy is discussed. A physics curriculum together with a physics syllabus in which astronomy is integrated is proposed. A historical approach in teaching astronomy is favored. The aims and difficulties involved in teaching astronomy, and the necessity of statutory teacher training courses are considered. ESA

N87-25066# Poznan Technical Univ. (Poland). Inst. of Physics.
ASTRONOMY IN POLISH HIGH SCHOOL **c80**
Henryk Szydlowski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 245-248 (For primary document see N87-25026 18-89)
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Astronomy teaching in Polish schools is described. Astronomy is not distinguished as a separate subject in any Polish elementary or high school. Astronomy is included in physics curricula. Astronomical problems included in the teaching of physics for particular profiles of high school are listed. ESA

N87-25067# Roskilde Univ. (Denmark).
THE PHYSICIST'S CONCEPT OF NATURE/THE UNIVERSE: RECENT DEVELOPMENTS IN SYLLABUS IN THE DANISH GYMNASIUM **c80**

Helge Kastrup *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 249-250 (For primary document see N87-25026 18-89)
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Teaching in astrophysics, astronomy, and cosmology (none of which are mandatory) to 16-19 yr old students is described. Gravitation and black holes, gravitation and cosmology, and comets and the solar System are covered. ESA

N87-25068# Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Science Teaching.
ASTROPHYSICS IN HIGH SCHOOL: WHAT AND HOW? c80
Zvi Geller and Uri Ganiel *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 251-253 (For primary document see N87-25026 18-89)
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An elective unit Introduction to Astrophysics, was developed for high school students who study physics at an advanced level. The topics covered in the unit are outlined, and the reasons for emphasizing some of these topics are explained. Examples of treatment of use of ideal gas laws for the interior of the Sun, and the evaluation of temperature in stellar cores are given. These emphasize feasibility arguments and qualitative considerations, since a rigorous treatment is beyond the ability of the students. Plans for implementation and teaching aids are described. ESA

N87-25069# Ljubljana Univ. (Yugoslavia). Dept. of Physics.
ON THE NEWTONIAN MODEL OF THE EXPANDING UNIVERSE c90
J. Strnad *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 255-260 (For primary document see N87-25026 18-89)
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A simple approach to teaching the Newtonian model of the Universe is suggested. The past and future of the Universe; and relativistic models are discussed. ESA

N87-25070# Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.
ASTRONOMY IN US HIGH SCHOOLS c80
Ph. M. Sadler *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 261-263 (For primary document see N87-25026 18-89)
(Grant NSF MDR-85-50297)
Copyright Avail: NTIS HC A20/MF A01

A national effort to promote the teaching of astronomy at the high school level in the U.S. is underway. A census of 11,100 high school was carried out to find the extent of astronomy offerings. Teachers of high school astronomy courses were identified and surveyed. An unanticipated number of astronomy courses are offered by surprisingly well qualified teachers. This has positive implications for curriculum development and expansion of astronomy teaching. ESA

N87-25071# Attila (Jozsef) Univ., Szedged (Hungary). Inst. for Experimental Physics.
TEACHING OF ASTRONOMY IN HUNGARIAN GRAMMAR SCHOOLS c80
Csaba Kalamar, Karoly Szatmary, and E. Toth *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 265-268 (For primary document see N87-25026 18-89)
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The contents of the Hungarian high school astronomy course are outlined, and the text of a lesson on the birth of stars is presented. The course covers the birth of stars; the Sun; the life of stars; the death of stars; the Solar system; the Earth; chemical evolution; biological evolution; space research; and mankind and energy. ESA

N87-25072# Pedagogical Faculty, Ostravia (Czechoslovakia). Dept. of Physics.
THE DEVELOPMENT AND THE STRUCTURE OF MATTER c80
Erika Mechlova *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 269-275 (For primary document see N87-25026 18-89)
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The conception of mathematical-natural science education for grammar school is presented. The objectives of astrophysical education are given and correlation between scientific and didactic systems of astrophysics are sought. Notions, fields, and concepts of the didactic system of astrophysics were worked out. Astrophysics connections with the fields of physics, the relations of laws of physics and their applications in astrophysics, and the main concepts of astrophysics are discussed. ESA

N87-25073# Futures' Museum, Falun (Sweden).
TWENTY-SEVEN STEPS TOWARD THE UNIVERSE: EXPERIMENTAL ASTRONOMY TEACHING IN PRIMARY AND SECONDARY SCHOOLS c80
Lars Broman *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 281-283 (For primary document see N87-25026 18-89)
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A sourcebook in experimental astronomy for school teachers is presented. The students are guided towards understanding of astronomic concepts by comparing observations of celestial phenomena done in the real world and in models. ESA

N87-25074# Perugia Univ. (Italy). Dipt. di Fisica.
TEACHING ON METEORITES c80
Franco A. Levi and G. R. Levi-Donati *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 285-291 (For primary document see N87-25026 18-89)
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An approach for teaching on meteorites in high school is presented. It is shown how meteorites are found and how they can be recognized. Classification of meteorites in the three broad groups (stones, irons, stony-irons) is outlined and information on their origin is given. ESA

N87-25075# Observatoire de Marseille (France).
THE TRAINING IN ASTRONOMY OF FRENCH PRIMARY AND SECONDARY SCHOOL TEACHERS c80
Marie-France Duval and G. Walusinski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 293-295 (For primary document see N87-25026 18-89)
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National, local, and voluntary teacher training in astronomy in France is described. Lesson preparation is also described. ESA

N87-25076# Porto Univ. (Portugal). Grupo de Matematica Aplicada.
TEACHING OF ASTRONOMY AT UNIVERSITY LEVEL IN PORTUGAL c80
Maria Teresa Vaz Tor Lago *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 297-298 Sponsored by the American Astronomical Society Henri Chretien Award (For primary document see N87-25026 18-89)
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The status of teaching of astronomy in Portugal at university level is described. The interdisciplinary degree in astronomy at the university of Porto is outlined. ESA

N87-25077# Osservatorio Astrofisico di Arcetri, Florence (Italy).
DIDACTIC ACTIVITIES OF THE ITALIAN ASTRONOMICAL SOCIETY (IAS) c80
Maria E. D. Pestellini *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov.

1986 p 299-301 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The contributions of the Italian Astronomical Society to teacher training and curriculum development are outlined. ESA

N87-25078# Wroclaw Univ. (Poland). Inst. of Physics.
THE HIERARCHICAL STRUCTURE OF THE UNIVERSE c90
T. Grabinska *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 303-308 (For primary document see N87-25026 18-89)
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The fractal approach to the hierarchical clustering of matter in the Universe is presented. It is compared with the properties and results of models which assume the continuous clustering of cosmic matter. The problem of mean density of this matter is discussed. Formulas for the mean density of hierarchically clustered matter are compared with the formulas obtained from fractal models of clustering. ESA

N87-25079# Utrecht State Univ. (Netherlands).
CAPRA IN THE CLASSROOM? c80
Piet L. Lijnse *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 311-312 (For primary document see N87-25026 18-89)
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Two video-programs for the general public on the relation of modern physics and spiritual thinking, as expressed in the works of Capra and others, are presented. It is asked whether this relation shouldn't also be taken into account when teaching about the cosmos. Both videos are suited for classroom use as well. ESA

N87-25080# Tokyo Astronomical Observatory (Japan).
PRESENT STATUS OF ASTRONOMICAL INSTRUMENTS AT THE SENIOR HIGH SCHOOLS AND AT THE PLANETARIUM IN JAPAN
Syuzo Isobe, G. Sasaki, and N. Shinohara *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 313-318 (For primary document see N87-25026 18-89)
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A questionnaire relating to astronomical instruments was sent to 3315 senior high schools and 215 planetariums in Japan, and 907 and 85 answers, respectively were received. As expected, many senior high schools have, at least, one small telescope, but only a small number of schools and planetariums have teachers and staff who studied astronomy at university level. The present status on the basis of astronomical instruments at the senior high schools and the planetariums in Japan is at a high level, but the software and teaching staff should be developed. ESA

N87-25081# Copenhagen Univ. (Denmark). Astronomy Observatory.
PUBLIC UNIVERSITY COURSES IN ASTRONOMY c80
Hans Joern Fogh Olsen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 321-323 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Public courses in astronomy in Denmark are described. The problems of finding suitable teaching material in Danish are discussed, and an exchange of copyright-free material for translation is suggested. ESA

N87-25082# Istituto Tecnico Industriale (Stanislao Cannizzaro), Milan (Italy).
ASTRONOMY AND COSMOS: CONCEPTS AND MISCONCEPTS IN COMMUNICATING SCIENCE c80
Ludovica Manusardi Carlesi *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 325-326 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Popular misconceptions concerning basic astronomical concepts, e.g., light year and weightlessness, are discussed. ESA

N87-25083# Sofia Univ. (Bulgaria).
STUDY OF HISTORY OF CULTURE BY TEACHING HISTORY OF ASTRONOMY c80
Nikola Stefanov Nikolov *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 329-332 (For primary document see N87-25026 18-89)
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It is shown how the history of astronomy may help the study of human culture. Archaeoastronomy; the calendar; the step-by-step achievements of the notions of the structure of the Universe; harmony; and the other ideas appearing in astronomy are discussed. ESA

N87-25084# Wroclaw Univ. (Poland). Inst. of Physics.
ON PHILOSOPHICAL ASSERTIONS IN COSMOLOGY c90
M. Zabierowski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 333-336 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Phylogenetic and ontogenetic aspects of cosmology are discussed. Static and dynamic universes; singularity; and Little Bang theories are discussed. ESA

N87-25085# Danish Space Research Inst., Lyngby.
ASTROPHYSICS AS AN EXAMPLE OF HOW SCIENTISTS WORK c90
Ib Lundgaard Rasmussen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 337-340 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

It is argued that astrophysics, being an observational rather than an experimental science, provides a lot of recent, easily accessible examples of the scientific process. Astrophysical examples can show science as a human activity and provide a better understanding of the epistemological problems underlying all scientific activity, thereby providing a truer picture of the role of science in modern society. ESA

N87-25086# Consiglio Nazionale delle Ricerche, Turin (Italy). Gruppo Nazionale di Didattica della Fisica.
AIMS AND DIFFICULTIES IN TEACHING HISTORY OF ASTRONOMY IN PHYSICAL COURSES: 10 YEARS' EXPERIENCE c80
Lidia Nuvoli *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 341-343 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Experience in introduction of history of astronomy and cosmology in high schools is presented. These topics can introduce students to the processes of modeling, giving in idea of the cosmic validity of physical laws, making also many links with social vicissitudes and philosophical theories. The method followed in Italy in class work (supported by an expressly made book), with students' preliminary reading of subsequent pieces, questions, and ensuing discussions is illustrated. ESA

N87-25087# Kaiserslautern Univ. (West Germany). Fachbereich Physik.
VIDEOFILMS OF SPACELAB MISSIONS IN COMBINATION WITH REAL EXPERIMENTS AND COMPUTER SIMULATION c80
H.-J. Jodl and U. Sader *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 347-348 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The use of films of space missions intercut with computer simulations to teach astronomy and other space sciences is described. A sequence on satellite motion is described. ESA

N87-25088# Rockwell Shuttle Operations Co., Houston, Tex.
INTERACTIVE SPACE EDUCATION AND SPACE SHUTTLE MISSION 51-L c80
P. D. Maley *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p

349-351 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Shuttle mission 51-L launched an interactive promotion of education direct from space. Emphasis on use of actual video scenes of space mission and astronomical phenomena are encouraged as tools in the classroom. Observation and prediction of Earth satellite passages foster space awareness and stimulating student interest. The spaceborne part of 51-L, teacher in space, was a victim of the Challenger disaster. ESA

N87-25089# Danish Space Research Inst., Lyngby.
THE EXPLORATION OF THE SOLAR SYSTEM AS AN EVERYDAY ACTIVITY c80
Ib Lundgaard Rasmussen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 353-354 Sponsored by the Danish Film Board, and the Egmont H. Petersens Foundation (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

A 1hr movie was made as part of a general introduction to science for children in Danish primary schools. The movie attempts to unite the everyday experiences of the children and the exploration of the solar system. This is done by combining a simple story about the life of one chicken in an oldfashioned hen coop with information on how the forces of nature shape the world around us. The world being described is both the local Danish countryside and the solar system. The movie provides a basis for discussion of gravity, erosion and entropy, wave motion and the nature of light, and the relation between theory and observations. ESA

N87-25090# Tokyo Astronomical Observatory (Japan).
A PHOTON COUNTING TV CAMERA FOR ASTRONOMICAL EDUCATION c32
Syuzo Isobe, G. Sasaki, N. Shinohara, and H. Agata *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 355-358 (For primary document see N87-25026 18-89)
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A system with an electron multiplier, two-stage microchannel plate, and a vidicon TV camera was developed for two dimensional photon counting imaging and applied to astronomical observations. Each sequence of images for M51 galaxy and M104 galaxy with different integration time are stored on a video tape. These images show how photons from celestial objects reach the detector. ESA

N87-25091# Western Australian Inst. of Tech., Perth. Science and Mathematics Education Center.
SECONDARY STUDENTS' UNDERSTANDING OF THE SOLAR SYSTEM: IMPLICATION FOR CURRICULUM REVISION c80
David Franklin Treagust and C. L. Smith *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 363-368 (For primary document see N87-25026 18-89)
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Secondary students' understanding of the Solar System following a course of instruction, and misunderstandings and misconceptions in Solar System Astronomy were examined. From open-ended group interviews, an 8-item group interview instrument was developed and administered to 24 students in Grade 10. A pencil and paper instrument was later administered to 113 Grade 10 students. Categories of misconceptions were identified which are associated with gravity and the Sun's source of energy. Recommendations to improve the teaching of Solar System astronomy are made. ESA

N87-25092# IRRSAE Piemonte, Torino (Italy).
EARTH, SKY AND MOTION. SOME QUESTIONS TO IDENTIFY PUPILS' IDEAS c80
Maria Luisa Viglietta *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 369-37 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

1986 p 369-37 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

A test to identify pupils' ideas concerning the motion of celestial bodies was given to a group of 11 year-olds. The majority claimed that the stars and the Sun are fixed but, most of the time, this belief is not supported by any explanation, other than that scientists, or some other authority, say it is so. Teaching does not seem to enhance pupils' ability to observe, describe, and explain everyday events seen in the sky. It is suggested that photography of motion, e.g., of sports events, could help to explain basic notions. ESA

N87-25093# Wyzsza Szkola Pedagogiczna, Cracow (Poland). Inst. of Physics.
TEACHING RELATIVITY OF MOTION IN PRIMARY SCHOOL AS A FIRST STEP FOR UNDERSTANDING COSMOLOGY, MODERN PHYSICS, AND ASTRONOMY c80
Jerzy Ogar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 371-373 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Aspects of teaching relativity of physical description of nature at elementary level are presented. The relativity of motion is described as a very important concept in physics education. It is necessary for understanding astronomy and simple questions of cosmology. Typical didactic mistakes and their influence on understanding astronomy and space science are mentioned, e.g., ignoring the frame of reference when discussing electric and magnetic fields in simple magnet and coil experiments. The Polish physics curriculum for primary school is quoted. ESA

N87-25094# Wyzsza Szkola Pedagogiczna, Cracow (Poland). Inst. of Physics.
IDEAS ABOUT PHYSICAL PHENOMENA IN SPACESHIPS AMONG STUDENTS AND PUPILS c80
Jerzy Ogar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 375-378 (For primary document see N87-25026 18-89)
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Students aged 15 to 22 were asked to describe or explain experiments carried out in a spaceship instead of on the Earth. The test questions cover kicks, centrifugal governors, physical training, acceleration, intermolecular forces, everyday objects (e.g., pendulum clocks), and inertia. The test paper and replies are given. ESA

N87-25095# Poznan Technical Univ. (Poland). Inst. of Physics.
SCIENCE FICTION IN TEACHING ASTRONOMY AND PHYSICS c80
A. Rolewicz and Henryk Szydlowski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 379-381 (For primary document see N87-25026 18-89)
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Clarke's story: The Great Whirl was used to teach elements of astronautics to 16 year old students. The students were asked to read the story and then to choose and solve physical problems taken from the story. Students were then asked to write a story that presets a physical or astronomical question. As a result of both experiments an increase in the interest in scientific problems is noted. ESA

N87-25096# Roskilde Univ. (Denmark).
SCIENCE FICTION AND TEACHING PHYSICS c80
Helge Kastrup *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 383-385 (For primary document see N87-25026 18-89)
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Science fiction (SF) stories which contain good physics are listed. New physical laws commonly found in SF are quoted. Examples of blunders in SF are given. Use of SF to stimulate interest in real science is advocated. ESA

N87-25097# Western Australian Coll. of Advanced Education, Perth. Dept. of Science.
LEARNING AND THE ACQUISITION OF A KNOWLEDGE STRUCTURE FOR THE DISCIPLINE OF ASTRONOMY c80
C. L. Smith and David Franklin Treagust *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 387-390 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

The knowledge structure of astronomy as perceived by experts was compared with structures of novice learners. The portrayal of knowledge structures was achieved by a word assocation instrument to map relational information about astronomy concepts. A multidimensional scaling procedure plotted astronomy concepts in concept space. While the structures from astronomers are almost identical, the structures for the novices differ greatly from the experts. Implications for curriculum design and the instruction of astronomy are drawn. ESA

N87-25098# Parainen Secondary School (Finland).
THE 40M OPEN AIR FOUCAULT PENDULUM OF EURAJOKI WATER TOWER, FINLAND c70
Jukka O. Mattila *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 393-394 (For primary document see N87-25026 18-89)
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A method of exploiting tall buildings like water towers for school pendulum experiments is described. A 40m long Foucault pendulum with a heavy bob is relatively insensitive even to moderate winds if used outdoors. This is especially so at high latitudes near the Arctic circle where the angular velocity of the plane of oscillation is greater than at lower latitudes. A laser-beam Foucault pendulum is presented. ESA

N87-25099# Trento Univ., Povo (Italy). Dept. of Physics.
PHOTOGRAPHY AND STARS
Vittorio Zanetti and F. Magri *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 395-399 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

Experiments at school and/or college level to introduce astronomical concepts, particularly about spectroscopy of stars and the Sun are outlined. The equipment needed is quite simple, and it consists mainly of an SLR camera with a tripod, without tracking and without a telescope. ESA

N87-25100# Complex of Schools-Lyceum, Ostrow Wlkp (Poland).
COSMIC DISTANCE SCALES IN THE CLASSROOM c90
Zenon Gubanski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 401-402 (For primary document see N87-25026 18-89)
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Methods used for measuring cosmic distances are explained, and the distances and proportions of the Universe are presented in scale models. ESA

N87-25101# Dunsink Observatory, Dublin (Ireland).
A SPECIFICATION FOR AN INTERACTIVE VIDEO TUTOR c80
Ian Elliott *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 403-406 (For primary document see N87-25026 18-89)
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Video disks as an astronomy class teaching tool, a small-group learning medium, an individualized tutor, and as a visual archive are considered. It is suggested that the software of authoring system type should feature good screen editing (you get what you see), legible text with a choice of fonts, good graphics generated quickly, good choice of colors, easy testing of modules, clear instructions and a concise manual, economic use of computer memory, and the ability to monitor a student's progress ESA

N87-25102# Attila (Jozsef) Univ., Szedged (Hungary). Inst. for Experimental Physics.
SEMIREGULAR RED VARIABLE STARS: A FIELD OF COOPERATION BETWEEN AMATEURS AND PROFESSIONALS
Karoly Szatmary *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 407-409 (For primary document see N87-25026 18-89)
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The observation of the long-period pulsating red giant stars by amateur astronomers is described. The general problem is period determination. Analysis of the light curve of seven stars was based on the discrete Fourier transformation method of unequally spaced date. Usually these variables oscillate in one or two radial modes, but sometimes in the power spectra more main peaks are visible. From the period values many physical parameters can be determined. It can be difficult to decide whether the pulsational behavior is multiperiodic regular or irregular as randomness and chaos. ESA

N87-25103*# Columbia Univ., New York. Astrophysics Lab.
FAR INFRARED OBSERVATIONS OF CRAB-LIKE SUPERNOVA REMNANTS Final Report, 1 Jun. 1985 - 31 May 1986
David J. Helfand and Robert H. Becker (California Univ., Irvine.) Jul. 1986 6 p Prepared for JPL
(Contract JPL-957252)
(NASA-CR-181081; JPL-9950-1299; NAS 1.26:181081; CAL-1615)
Avail: NTIS HC A02/MF A01 CSCL 03A

Using the Infrared Astronomy Satellite (IRAS) data, an investigation was begun of the far infrared properties of Crab-like supernova remnants and other synchrotron nebulae. Both the co-added scanning data and, where available, pointed observations were examined. To date infrared emission was found from two Crab-like remnants: G24.7+0.6 in which the infrared source near the center of the object was shown to be a compact HII region with EM greater than or approximately 10 to the 7th pc/cm(6); and G0.9+0.1 where a marginal detection of a 25 micron source coincident with the remnant core was used to set limits on the energetics of this synchrotron nebula. Further work, in progress under a second year of this program, should yield additional information concerning the distribution of initial pulsar spin periods and the evolution of synchrotron nebulae. Author

N87-25104# Smithsonian Astrophysical Observatory, Cambridge, Mass.
APPLICATION OF IMAGING TO GAMMA RAY ASTRONOMY Progress Report, 1986 - 1987
1987 9 p
(Contract DE-AC02-82ER-40063)
(DE87-008404; DOE/ER-40063/1) Avail: NTIS HC A02/MF A01

In March 1986, the Mark II Iowa State camera electronics utilizing CAMAC modules interfaced to an LSI-11/73 computer was installed and tested at the Whipple Observatory. A study of the noise, gains, and spectral response of the photomultiplier tubes which comprise the camera was made. Also, detections of pulsed neutron star spin periods have provided an opportunity for tests of various techniques of signal-background discrimination. Observation have concentrated on x-ray binaries. As a preliminary step to constructing a full size camera, a new 37 element mini-camera is being constructed. Short summaries are presented on new computer equipment, testing of the Cherenkov detectors under moonlight, the construction of a muon telescope, and the design and testing of a fast trigger for the gamma ray camera system. DOE

N87-25105 Arizona Univ., Tucson.
IRAS OBSERVATIONS OF ASTEROID DUST BANDS AND COMETARY DUST TRAILS Ph.D. Thesis
Mark Vincent Sykes 1986 274 p
Avail: Univ. Microfilms Order No. DA8704791

Analysis of data from the Infrared Astronomy Satellite (IRAS) resulted in the discovery of bands of dust surrounding the inner solar system, consisting of asteroid collision debris. Narrow trails

of dust were also discovered tracking the orbits of a number of short-period comets. Pairs of dust bands are the product of individual collisional events in the asteroid belt. A dynamical model is developed which shows how the orbits of debris from such collisions evolve to form a band pair. A model of the surface area evolution of such bands is also developed which, coupled with asteroid collision theories, indicates that some of the observed dust bands are the consequence of the disruption of approximately 10 km diameter asteroids within the last approximately 10 to the 7th years. From the above models, it is possible to account for the bulk of the zodiacal thermal emission, increasing the importance of asteroid collisions as a source of interplanetary dust. Analysis of the dust trails indicates possible differences in structure and composition among comet nuclei. Preliminary results from a survey of dust trails in the IRAS data indicate the presence of a large number of previously unobserved short-period comets.

Dissert. Abstr.

N87-25106 Pennsylvania State Univ., University Park.
THE DESIGN AND IMPLEMENTATION OF COMPUTER SYSTEMS FOR ASTRONOMICAL USE AT THE PENNSYLVANIA STATE UNIVERSITY Ph.D. Thesis
Ryland James Truax 1986 278 p
Avail: Univ. Microfilms Order No. DA8705427

As The Pennsylvania State University Department of Astronomy expanded and new research projects were undertaken in the 1970's and 1980's it became apparent that the available computing facilities would not be adequate. An analysis, design, and implementation program was undertaken to develop four computer systems which would meet the needs of these research projects. This thesis presents each of these computer systems as a case study of a problem and its solution. The first two case studies present computer systems developed to control astronomical instruments at the Black Moshannon Observatory and to reduce spectral data obtained at the observatory. The third case study presents a computer system which uses the UNIX operating system for laboratory instrument control. The fourth case study presents The Pennsylvania State University Astronomical Image Processing System (PSAIPS) developed to meet the needs of two-dimensional CCD images and Radio Astronomy observations. The thesis shows that these systems apply new technology and techniques to astronomical problems, and consistently meet or exceed the needs of the research projects they were designed to support.

Dissert. Abstr.

N87-25107# Instituto y Observatorio Astronomico de Marina, San Fernando (Spain).
CARLSBERG MERIDIAN CATALOG LA PALMA (SPAIN), NO. 2. OBSERVATIONS OF POSITIONS OF STARS AND PLANETS MADE IN THE YEAR 1985
1986 217 p Prepared in cooperation with Copenhagen Univ., Denmark, and the Royal Greenwich Observatory, Herstmonceux, England
(ISBN-84-7496-039-0; ETN-87-99848) Avail: NTIS HC A10/MF A01

Positions in the FK4 system for the equinox J2000.0, proper motions, and magnitudes of 10,718 stars north of minus 45 deg declination are given. The limiting magnitude is 13.2. The stars include 4549 IRS stars, 400 HIPPARCOS stars with poor astrometic history, 252 PZT, 513 reference stars, around 204 benchmark radio sources, 3014 F-stars within 100 pc, 329 reference stars for comet Halley, and 94 radio stars. The zenith mean errors are epsilon alpha cos delta = 0.190'; epsilon delta = 0.184'; and epsilon m = 0.057 m. The proper motion mean errors are typically 0.003' per year. The catalog also contains 1785 observations of 3 major and 55 minor planets. Cross-references are given to DM, AGK3, SAO, HD and the double star catalogs ADS and IDS.

ESA

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

N87-25108# Florida Univ., Gainesville. Dept. of Physics.
ESTIMATES OF THE DENSITY OF DARK MATTER NEAR THE CENTER OF THE GALAXY
J. R. Ipser and P. Sikivie 31 Mar. 1987 35 p
(Contract DE-FG05-86ER-40272)
(DE87-008765; DOE/ER-40272/33; UFTP-87-5) Avail: NTIS HC A03/MF A01

The COS-B satellite observations of the cosmic gamma-ray flux are sensitive to gamma-rays from dark matter annihilation at the center of the Galaxy if the dark matter is composed of stable weakly interacting particles such as photinos, higgsinos, sneutrinos or heavy neutrinos and if the dark matter content of the central component of the Galaxy is more than about 2%. Motivated by this remark, we have studied how much dark matter is expected to be near the center of the Galaxy under two different assumptions called the isothermal and adiabatic models. In the first, the dark matter is assumed to be isothermally distributed. In the second, it is assumed that while the central component forms the adiabatic invariant for the radial motion of each dark matter particle, as well as its angular momentum, is conserved. In the isothermal model, the typical dark matter density enhancement near the center of the Galaxy is large enough to make the COS-B data sensitive to the hypothesis that the dark matter is composed of stable weakly interacting particles, whereas in the adiabatic model it is about a factor of five too small. It is shown that, in the latter case, the density of dark matter particles near the center of the Galaxy is proportional to (-phi/sub c/(r))/sup 3/2/ where phi/sub c/(r) is the gravitational potential due to the central component.

DOE

N87-25109# European Space Agency, Paris (France).
PROCEEDINGS OF AN ESA WORKSHOP ON THE COMET NUCLEUS SAMPLE RETURN MISSION
Olga Melita, comp. Dec. 1986 244 p Proceedings held in Canterbury, England, 15-17 Jul. 1986
(ESA-SP-249; ISSN-0379-6566; ETN-87-99857) Copyright Avail: NTIS HC A11/MF A01

The goals of ESA's and NASA's comet nucleus sample return mission; comet selection; sampling and storage requirements; mission options; returned sample science; technological developments; and links with the Space Station were discussed. For individual titles, see N87-25110 through N87-25138.

N87-25110# Sussex Univ., Brighton (England). Astronomy Center.
COSMOGONIC PROBLEMS TO BE STUDIED FOR AND BY MEANS OF COMET SAMPLES
William McCrea *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 9-14
(For primary document see N87-25109 18-90)
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Comet nuclei; the origin of small solar system bodies; comet dynamics as exemplified by the Oort cloud; comet formation as an original part of the solar system; and interstellar comets are discussed in the context of ESA's comet nucleus sample return mission.

ESA

N87-25111*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HOW PRISTINE ARE COMETARY NUCLEI?
Paul R. Weissman *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 15-25 Sponsored by the NASA Planetary Geology and Geophysics Program (For primary document see N87-25109 18-90)
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The claim that comets are the best obtainable source of original solar nebula material is assessed. To fully interpret the cosmochemical record contained in the comet nuclei, modifications

since their formation in the primordial solar nebula, 4.5 Gyr ago must be considered. Possible processes include: comminution and collisions during formation; heating by short-lived radionuclides; accretion of interstellar gases; erosion by interstellar dust; polymerization by galactic cosmic rays; and heating and thermal evolution when the comets return to the planetary region. Consideration of these processes has important implications for where and how a sample is obtained on the cometary nucleus, and how it is preserved during the return to Earth. The possible dynamical history of short-period comets is discussed. ESA

N87-25112# Max-Planck-Inst. fuer Kernphysik, Heidelberg (West Germany).
ON THE AVERAGE CHEMICAL COMPOSITION OF COMETARY DUST
Elmar K. Jessberger, Jochen Kissel, Hugo Fechtig, and Franz R. Krueger *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 27-30 (For primary document see N87-25109 18-90)
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Analyses of mass spectra obtained by the particulate impact analyzers onboard the Vega and Giotto spacecraft are described. Analyzing a subset of 23 selected spectra obtained with identical instrument conditions produces a preliminary average abundance pattern of major and minor elements in Halley's dust. Within a factor of two the pattern is chondritic for the major elements. Carbon is enriched by a factor of 8 compared to C1 chondrites. Halley's dust is composed of chondritic silicates and refractory carbonaceous material. ESA

N87-25113*# Chicago Univ., Ill.
WHAT CAN METEORITES TELL US ABOUT COMETS?
Edward Anders *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 31-39 (For primary document see N87-25109 18-90)
(Grant NAG9-52)
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Cometary silicates, carbon, and volatiles are reviewed using data from the Halley probes, interplanetary dust particles, and cometary spectra. The origins of anhydrous Fe(2+)-bearing silicates; whether hydrated silicates, if present, were made by gaseous or liquid H2O3; sources of organic compounds: ion-molecule reactions, photochemistry, grain catalysis; sources of CO2 and of organic polymers; and interstellar molecules and grains in comets are discussed. ESA

N87-25114# Open Univ., Milton (England). Dept. of Earth Sciences.
INTERSTELLAR DUST COMPONENTS IN METEORITES: IMPLICATIONS FOR A COMET NUCLEUS SAMPLE RETURN
C. T. Pillinger *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 41-45 (For primary document see N87-25109 18-90)
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Measurements of noble gas, carbon, and nitrogen isotopes in residues obtained from primitive meteorites by acid dissolution and chemical oxidation are discussed. They suggest that interstellar dust grains survived intact the processes involved in condensation from the solar nebula. The state of knowledge, which recognizes at least 3 carbonaceous dust components, C alpha, Beta, and delta, 2 enriched and 1 depleted in C 13 with distinct noble gas signatures Ne-E(L), s-Xe and Xe(HL) respectively is reviewed. The latter component is also distinguished by nitrogen enriched in N14. Other nitrogen isotope measurements point to the existence of additional extrasolar material, possibly carbonaceous or sulfides. It is anticipated that interstellar dust grains could be a major contributor to comet nuclei. ESA

N87-25115# Huygens Laboratium, Leiden (Netherlands).
EVIDENCE FOR THE PRISTINE NATURE OF COMET HALLEY
J. Mayo Greenberg *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 47-55 (For primary document see N87-25109 18-90)
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47-55 (For primary document see N87-25109 18-90)
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It is argued that cometary material, as deduced from comet Halley results, bears a remarkable resemblance to the chemical and morphological structure of a primitive aggregate of interstellar dust. The principal clues are found in the sizes of cometary dust, the nonvolatile organics in cometary dust, the surface albedo, the physical and photochemical break-up of the dust molecules in the coma via the appearance, for example, of CN and very abundant C(+) ions, the high surface temperature but low internal temperature, low comet density, solar orientation of gas and dust jets, and low C/O ratio in coma. There are several reasons to expect no significant modification of the interior and even of the surface of the nucleus of comet Halley since it was formed 4500 million yr ago. This implies that gentle handling and cold retrieval of comet nucleus material may reveal the true nature of the primeval material out of which it formed. ESA

N87-25116# Lecce Univ. (Italy). Dept. of Physics.
COSMIC DUST ANALOGS: A LABORATORY APPROACH
E. Bussoletti, A. Borghesi, and L. Colangeli *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 57-62 (For primary document see N87-25109 18-90)
(Contracts CNR-84.00220; CNR-85.00281)
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It is shown that the study of the interstellar extinction and spectral features (absorption/emission) in the infrared, observed in astronomical spectra, provides indications about likely material candidates for cosmic dust. Carbonaceous materials as silicon carbide, amorphous carbon, also in hydrogenated form (HAC), and mixtures of HACs with polycyclic aromatic hydrocarbons were studied in laboratory under carefully controlled experimental conditions. The diagnostic problem on the form and composition of the cosmic grains is still open. ESA

N87-25117# University Coll., Cardiff (Wales). Dept. of Applied Mathematics and Astronomy.
COMPOSITION AND EVOLUTION OF COMETARY NUCLEI
M. K. Wallis *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 63-67 (For primary document see N87-25109 18-90)
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Ideas of nucleus structure are reviewed in the light of the Halley missions and spectroscopic studies. Nucleus splitting; brightness outbursts and vanishing; activity as far out as Jupiter and beyond are supplemented by directed jet emissions, irregular surges, and a warm black surface. Carbonaceous rather than mineral particulates, and sulfur and carbon compounds seem to be more important, with little evidence of volatile elementary gasses. Exotic energy sources (chemical, physical (phase change), radiogenic) may have a role, but the primary source is solar radiation, possibly captured in subsurfce ice by a greenhouse effect. An evolving inhomogeneous surface and structured surface layers dominate the comet's behavior. ESA

N87-25118# European Space Agency, Paris (France). Lab. de Glaciologie et de Geophysique de l'Environnement.
POSSIBLE ALTERATIONS OF MATTER IN PERIODIC COMETS
J. Klinger *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 69-74 (For primary document see N87-25109 18-90)
(Grant ATP-47-54)
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The modifications of texture, structure, and composition that cometary matter may have undergone due to solar heating since the comet is on a periodic orbit are discussed. It is found that very volatile ices were depleted, and clathrate hydrates formed from initially amorphous mixtures. Dust was enriched and isotope ratios slightly modified. Criteria for the selection of the target of a comet nucleus sample return mission are discussed. ESA

N87-25119# Justus Liebig-Universitaet, Giessen (West Germany). Inst. of Physics.
ION PROPULSION SYSTEMS **c20**
Horst W. Loeb *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 75-92 (For primary document see N87-25109 18-90)
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The principles and performances of ion propulsion systems are reviewed. Engines developed for the U.S.S.R. space program, NASA, and ESA are described. A cluster of RIT-35 engines is proposed for the ESA comet nucleus sample return mission.
ESA

N87-25120# Teledyne Brown Engineering, Pasadena, Calif.
COMET NUCLEUS SAMPLE RETURN MISSION WITH ELECTRICALLY PROPELLED SPACECRAFT
E. Stuhlinger, H. Fechtig, E. Igenbergs, and H. Loeb (Justus Liebig-Universitaet, Giessen, West Germany) *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 93-102 (For primary document see N87-25109 18-90)
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A mission to return several kilograms of cometary nucleus material to Earth is described. The total delta-v requirement of this mission amounts to 40 km per sec. It can be produced by the combination of a launch vehicle that puts the spacecraft on its cometary transfer trajectory; an electric or ion propulsion system that enables the spacecraft to rendezvous with the comet, and to return to the Earth's solar orbit after the cometary rendezvous; a chemical propulsion system that permits the spacecraft to maneuver in the vicinity of the comet; an orbital transfer vehicle that meets the returning spacecraft in the Earth's solar orbit and takes it back into a low Earth orbit; and an Earth-return vehicle that retrieves the cometary samples to Earth. Comet Wild 2 is a suitable candidate during its 1997 perihelion passage. ESA

N87-25121# European Space Agency. European Space Operations Center, Darmstadt (West Germany).
COMET NUCLEUS SAMPLE RETURN (CNSR): MISSION ANALYSIS ISSUES
M. Hechler *In its* Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 103-110 (For primary document see N87-25109 18-90)
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Mission selection and mission planning for the ESA comet nucleus sample return mission definition study are summarized. The options of an aphelion rendezvous with chemical propulsion and an Earth gravity assist, and a periphelion rendezvous with solar electric propulsion are concentrated on. Launch options taken into account are shuttle with upper stage or an expendable launcher (e.g., Ariane 5). Capture at Earth return is by a chemical retro maneuver or preferably by guided atmosphere passages. Navigational aspects of interplanetary cruise and comet approach are presented, and a sequence of mission events is outlined.
ESA

N87-25122# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
COMET NUCLEUS SAMPLE RETURN (CNSR) MISSION: ESA ACTIVITIES AND PRELIMINARY DESIGN
A. Atzei *In its* Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 111-121 (For primary document see N87-25109 18-90)
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System studies and technology development in preparation for the implementation of the ESA comet nucleus sample return mission are summarized. Spacecraft propulsion (RIT and solar); navigation; drilling mechanisms; power supplies; and imaging instruments are discussed. ESA

N87-25123# Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.
COMET NUCLEUS MODELS: A REVIEW
John A. Wood *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 123-131 (For primary document see N87-25109 18-90)
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Observed properties and conceptual models of comet nuclei are reviewed, to aid in the planning of a sample return mission to a comet. Nuclear properties are understood (the 1986 spacecraft encounters with P/Halley provided much valuable information): dimensions, large-scale morphology, albedo, water-ice as the predominant constituent, proportions of dust and ice, and the size, distribution, and composition of the dust. However, knowledge in other areas, including information crucial to the design of an optimal mission, is still very poor: the small-scale surface roughness, internal heterogeneity (vertically and otherwise), properties of cometary mantles, the state in which compounds other than H_2O are incorporated, and the physical properties of nuclear material (porosity, density, strength, and effective thermal conductivity).
ESA

N87-25124*# Rice Univ., Houston, Tex.
COMETARY MEMORY OF INTERSTELLAR ALUMINUM
Donald D. Clayton *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 135-142 Sponsored in part by the Robert A. Welch Foundation (For primary document see N87-25109 18-90)
(Grant NSG9-100)
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It is shown that the distribution of refractory metals in a comet-nucleus drill core carries a chemical memory quite distinct from that of volatiles. Using aluminum as an example, it is demonstrated that very refractory structures, either grain cores or refractory aggregates of cores, must be much older than the volatile component. It is argued that isotopic anomalies are specifically associated with aluminum. An evolutionary model capable of rationalizing the interstellar gas depletions of Al and Mg is advocated. The distribution of Al in comets is shown to be crucial to understanding the origin of comets and of the solar system.
ESA

N87-25125# European Space Agency, Paris (France).
PHOTOCHEMICAL STUDIES OF S2 FORMATION AND THEIR IMPLICATIONS ON THE SOURCE AND EVOLUTION OF COMETS **c25**
R. J. A. Grim and J. M. Greenberg *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 143-151 (For primary document see N87-25109 18-90)
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The formation of S2 by ultraviolet photoprocessing of interstellar ices is shown to be a plausible explanation for the observation of this molecule in comet IRAS-Araki-Alcock 1983d. Not only S2 is to be expected in cometary ices but also such products as SH, SO, CS, CS2, HSO, OCS etc. The composition of the processed interstellar analog ices is compared with molecular production rates in comets. When the water fraction is greater than 60% to 80%, S2, and other volatile species, can remain trapped in the cometary ice for greater than 100 million yr as long as T less than or = 100 K. Thus comet formation in the Uranus-Neptune zone, or further out are both acceptable. It is of great importance to sample cometary ice in its original form, so that not only the physical and chemical structure of comets are revealed, but also that of the incorporated interstellar grains. ESA

N87-25126# Technische Univ., Vienna (Austria). Inst. of Geochemistry.
VOLATILE ELEMENTS IN THE EARLY SOLAR SYSTEM AND COMET NUCLEUS SAMPLES
Christian Koeberl *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 153-159 (For primary document see N87-25109 18-90)
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The study of volatile trace element concentrations in the solid parts of comet nuclei samples is discussed. Volatile elements are depleted even in primitive meteorites when compared to solar abundances. Since solar abundances are not too well known, cosmic abundances are usually derived from meteorites. In spite of the volatility of elements it seems more reliable to take these abundances from unprocessed cometary material. The behavior of volatile elements and their compounds is different in the outer part of the solar nebula. Homogeneous and heterogeneous accretion models predict different volatile elements compounds. In meteorites only products from homogeneous accretion are detected, but in the low temperature parts of the nebula the condensation behavior may have been different. ESA

N87-25127# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Chemie 1.
HOT ATOM CHEMISTRY IN COMETS
K. Roessler *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 161-164 (For primary document see N87-25109 18-90)
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Potential sites and kinds of hot reactions in a comet such as P/Halley are discussed. Hot species are provided by solar wind, cosmic rays, and photon induced dissociation processes. More important than the primary hot particles are the secondaries created by energy transfer to substrate atoms. Systems studied in simulation experiments via nuclear recoil and ion implantation techniques comprise carbon and nitrogen projectiles and gaseous or frozen H2O, NH3 and CH4. With a short period comet, hot atom reactions take place particularly in comae and tails. In the nucleus, they are less important when the comet is near the Sun, since only cosmic rays or hard photons can penetrate. Solid state hot atom chemistry, however, seems to be important for nuclei in positions far from the Sun and for their history prior to compaction in the early solar system or in the interstellar dust phase. ESA

N87-25128# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Chemie 1.
TEMPERATURE RECOMMENDATION TO PRESERVE A CHEMICAL STATUS QUO OF COMETARY SAMPLES c25
K. Roessler and B. Nebeling *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 165-168 (For primary document see N87-25109 18-90)
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On the basis of experiments on radiation induced reduction and oxidation of organics in ice and frozen NH3, a sampling and return temperature of T = 100 K is recommended for the ESA comet nucleus sample return mission. The temperature should at least not exceed that of the surface near interior (some meters depth), i.e., 130 K. ESA

N87-25129# Centre National de la Recherche Scientifique, Saint Martin d'Heres (France). Lab. de Glaciologie et Geophysique de l'Environnement.
RISK OF PHYSICAL AND CHEMICAL ALTERATION OF COMET NUCLEUS SAMPLES DURING TRANSFER TO EARTH c25
J. Ocampo, B. Schmitt, and J. Klinger *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 169-171 (For primary document see N87-25109 18-90)
(Grant ATP-47/89)
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Possible alterations of low temperature condensates like amorphous ices and clathrate hydrates with pressure, temperature, and time are discussed. Laboratory data from microporous ice and from clathrates hydrates of CO2 and Kr were used to give recommendations for the return of cometary samples. ESA

N87-25130# Sheffield Univ. (England). Dept. of Physics.
METEOROIDS: THE BEST CLUES TO THE STRUCTURE OF THE COMETARY NUCLEUS?
David W. Hughes *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 173-179 (For primary document see N87-25109 18-90)
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The decay of cometary nuclei into meteoroid showers is reviewed. Meteoroids provide important clues as to the density, strength, composition, thickness, and smoothness of the surface layer of the cometary nucleus, and also provide a guide to the cometary formation mechanism and enable the amount of mass previously lost by a comet to be calculated. ESA

N87-25131# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).
A COMPARISON OF NUCLEUS SURFACE MODELS TO SPACE OBSERVATIONS OF COMET HALLEY
W.-H. Ip and H. Rickman *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 181-184 (For primary document see N87-25109 18-90)
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Spacecraft observations of comet Halley revealed that the surface structure of its nucleus is highly complex with localized regions as major suppliers of sublimating gas flow while the main part is covered by a dust layer. A synthesis of published results and existing theoretical models suggests that the nucleus surface of comet Halley may be characterized by the presence of a number of (nearly) dust-free spots with integral areas amounting to 20% to 30% of the hemispherical area. A few percent of the surface area constitutes an outgassing network distributed uniformly over the entire surface. The third component is the background regions covered by dust mantle with an effective thickness of a few cm. ESA

N87-25132# Astronomical Observatory, Uppsala (Sweden).
FORMATION AND BLOWOFF OF A COMETARY DUST MANTLE
H. Rickman and J. A. Fernandez *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 185-194 (For primary document see N87-25109 18-90)
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A theory for a comet dust mantle based on diffusive gas transport with a mean free path set by the minimum grain radius is outlined. Numerical models, for evolutions representing comets Kopff and Halley are presented. The formation of the mantle is modeled in terms of grain trapping. Gas production is very efficiently quenched and consequently the mantle evolution is governed by the heat flow in the icy core. A wide variety of possible behaviors appears for both comets. Due to rapid surface recession very low temperatures may occur at shallow depth near perihelion in the absence of a mantle. Due to difficulties with the model of mantle formation, as to outgassing, a different picture where the mantle develops gradually in local patches is suggested. ESA

N87-25133# Astronomical Observatory, Uppsala (Sweden).
MASSES AND DENSITIES OF COMETS HALLEY AND KOPF
H. Rickman *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 195-205 (For primary document see N87-25109 18-90)
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Mass determination of cometary nuclei using nongravitational forces is reviewed and it is shown that accurate results can be reached if proper account can be taken of the influence of gas production perihelion asymmetry on the nongravitational effect. This requires that the gas production curve can be monitored with reasonable precision and that observations of the gas production pattern can set narrow limits on the average sublimation lag angle projected onto the orbital plane. Large uncertainties remain even for P/Halley but rho = 0.1 to 0.2 g/cc can be estimated. For P/Kopf only rough limits can be set, but this indicates a density which is probably even lower. A very high thermal conductivity appears necessary for comet Kopf. By neglecting H2O production from icy grains, cometary densities may be overestimated. ESA

N87-25134# Technische Univ., Munich (West Germany). Lehrstuhl fuer Raumfahrttechnik.
PARAMETRIC STUDIES FOR COMETARY NUCLEUS SAMPLE RETURN MISSIONS USING ELECTRICALLY PROPELLED SPACECRAFT
D. Schobert, E. Igenbergs, and M. Obersteiner *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 207-210 (For primary document see N87-25109 18-90)
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Comet nucleus sample return mission launcher configurations are discussed: Titan 34D7/G'; Ariane 5/H10; and Ariane 44L, represented by 3 injected mass/escape energy configurations. Additional missions must be investigated to obtain more insight on the influence of the parameters that describe the mission requirements. The values obtained indicate that the dry mass of the ion propulsion system must be well below 1.5 kg/mN thrust to obtain a reasonable payload back to Earth. The total mass ratio of this type of missions is below 2, i.e., more than half of the launch mass returns to Earth, including a 15% in situ mass at the comet. ESA

N87-25135*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SAMPLING THE COMETARY NUCLEUS
B. C. Clark, R. J. Amundsen (Martin Marietta Aerospace, Denver, Colo.), and D. P. Blanchard *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 211-216 (For primary document see N87-25109 18-90)
(Contract NAS9-17511)
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Three modes for obtaining samples of cometary material: remote sampling, hover mode sampling, and landed (anchored) sampling are discussed. For each mode, trade-offs involving complexity, risk factors, and cost must be analyzed for the spacecraft and the sampling system. Flyby results for comet Halley indicate heterogeneity in the cometary nucleus that could dictate sampling at several different locations. Coring drills, drive tubes, and specialized mantle sampling devices must operate at cold temperatures (100 to 180 K) without heating the sample. Sample selections must be accomodated by the sample return canister, which must also be protected from thermal excursions. ESA

N87-25136# Astronomische Rechen-Institut, Heidelberg (West Germany).
A GROUND-BASED OBSERVING STRATEGY FOR FUTURE COMETARY MISSIONS **c12**
S. Roeser *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 217-219 (For primary document see N87-25109 18-90)
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Problems related to and preparations to be undertaken for an observing campaign of target comets are discussed. Use of past observations; reference stars; and imaging systems are considered. ESA

N87-25137# Observatoire du Mont-Gros, Nice (France).
FEASIBILITY OF A MISSION TO COMET P/SCHWASSMANN-WACHMANN 1 **C12**
D. Benest and J. Klinger (Centre National de la Recherche Scientifique, Saint Martin d'Heres, France) *In* ESA Proceedings of an ESA Workshop on the Comet Nucleus Sample Return Mission Dec. 1986 p 221-224 (For primary document see N87-25109 18-90)
(Grants ATP-5773AP86; ATP-5729)
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Technical constraints on a sample return mission to comet Schwassmann-Wachmann 1 are discussed. Two situations were considered: The spacecraft is launched on a Hohmann orbit and the time of rendezvous is determined; the rendezvous takes place at a node of the cometary orbit and the spacecraft orbit is computed backward to determine the time of launch. The mission is feasible, and a slow flyby dropping a landing probe is easiest. ESA

N87-25138# European Space Agency, Paris (France).
A MULTI-COMET FLYBY/DUAL-COMET SAMPLE RETURN MISSION
Robert W. Farquhar, Malcolm B. Niedner, Stephen P. Maran, David W. Dunham, and Shao-Chiang Hsu (Computer Sciences Corp., Silver Spring, Md.) *In* ESA Proceedings of an ESA Workshop on Comet Nucleus Return Mission Dec. 1986 p 225-231 (For primary document see N87-25109 18-90)
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A flyby mission that would collect partially-intact dust samples from the comae of two comets (Tempel-1 and Tempel-2) and return them to Earth for analysis is proposed. The mission would also provide detailed measurements of the gas, dust, plasmas, and fields of cometary comae (Tempel-1, Tempel-2, and Encke), and high-resolution nucleus imaging. Returned samples and in situ measurements will provide valuable insight on the structure and primitive nature of comets, and would be extremely important in establishing comparative studies of comets. The scientific rationale and the means to carry out such a mission are discussed. ESA

N87-25139*# Catholic Univ. of America, Washington, D.C. Dept. of Mechanical Engineering.
STREAM STRUCTURES IN THE OUTER HELIOSPHERE Final Report
Y. C. Whang 15 Jul. 1987 25 p
(Grant NAG5-792)
(NASA-CR-180429; NAS 1.26:180429) Avail: NTIS HC A02/MF A01 CSCL 03B

Nineteen magnetic clouds are identified in the years from 1978 through 1982 and studied by the superimposed epoch method. The magnetic fluctuations, density, and temperature are enhanced ahead of the clouds preceded by shocks. Strong magnetic field intensities and low proton temperatures are observed in the clouds. A relatively large (2.5%) decrease in cosmic ray intensity is caused by the turbulent sheath behind an interplanetary shock ahead of a magnetic cloud. Only a small (0.5%) decrease in intensity is associated with the magnetic cloud itself. Magnetic clouds can produce geomagnetic activity with a decrease in the Dst index of the order of 100 gammas. The magnitude of the change in Dst index for the case when southward fields arrive first is comparable to that for the case of northward fields first, and the phase is such that geomagnetic activity is associated with the southward fields. Author

N87-25140*# Clemson Univ., S.C. Dept. of Physics and Astronomy.
[THE ROLE AND BEHAVIOR OF SPIN IN GRAVITATIONAL PHYSICS] Final Report, 15 May 1986 - 15 May 1987
John R. Ray 14 Jul. 1987 6 p
(Grant NAG8-048)
(NASA-CR-180654; NAS 1.26:180654) Avail: NTIS HC A02/MF A01 CSCL 03B

A self-consistent method of introducing spin into any Lagrangian based theory of gravitation was developed. The metric variation of the Lagrangian in the theory leads to an improved energy-momentum tensor which represents the source term in the gravitational field equations. The goal of the research is the construction of a theory general enough to be used to investigate spin effects in astrophysical objects and cosmology, and also to serve as a basis for discussion of the theoretical ideas tested by the NASA Gyroscope Experiment (aboard Gravity Probe B). Specific accomplishments in the following areas are summarized: the inclusion of electromagnetism into the variational principle for spinning matter, formulation of a self-consistent theory for the case of a fluid in which particle production processes occur, and the derivation of the Raychaudhuri equation in the case of spinning matter. M.G.

N87-25141# European Space Agency, Paris (France).
PROCEEDINGS OF THE 20TH ESLAB SYMPOSIUM ON THE EXPLORATION OF HALLEY'S COMET. VOLUME 1: PLASMA AND GAS
B. Battrick, ed., E. J. Rolfe, ed., and R. Reinhard, ed. Dec. 1986

623 p Symposium held in Heidelberg, West Germany, 27-31 Oct. 1986; sponsored by the Inter-Agency Consultative Group, the International Halley Watch, COSPAR, and the International Astronomical Union
(ESA-SP-250-Vol-1; ISSN-0379-6566; ETN-87-99858) Copyright Avail: NTIS HC A99/MF A01; print copy avail. from EPD, ESTEC, Noordwijk, The Netherlands Dfl 175 (3 volumes)

The results from six space probes that encountered Halley in March 1986, together with other Halley observations from space and from the ground, and theoretical and laboratory work are presented. This volume contains the gas and plasma papers. Topics covered include the Giotto, Vega, Sakigake, Suisei, and ICE flyby missions to comets Halley and Giacobini-Zinner. Also ground-based observations of gas and plasma phenomena were discussed. For individual titles, see N87-25142 through N87-25250.

N87-25142# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
THEORY AND OBSERVATIONS OF SOLAR WIND/COMETARY PLASMA INTERACTION PROCESSES c92
A. A. Galeev *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 3-17 (For primary document see N87-25141 18-90)
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Solar wind-comet interaction measurements aboard the space probes to comets Giacobini-Zinner and Halley revealed the complexity of the boundaries and the importance of collective plasma processes. Observational results include the discovery of upstream waves and strong plasma turbulence, the microstructure of bow shock, and the plasma waves and instabilities in the comae and within characteristic boundaries. There is no complete kinetic theory of solar wind interaction with comets, so the measurements are compared with only fragments of such theory based mainly on quasilinear theory of plasma and particle simulations. ESA

N87-25143*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE PICK-UP OF COMETARY PROTONS BY THE SOLAR WIND
M. Neugebauer, A. J. Lazarus, K. Altwegg, H. Balsiger, B. E. Goldstein, R. Goldstein, F. M. Neubauer, H. Rosenbauer, R. Schwenn, E. G. Shelley (Lockheed Aircraft Corp., Palo Alto, Calif.) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 19-23 Previously announced as N87-19342 Original contains color illustrations (For primary document see N87-25141 18-90)
(Grant NGL-22-009-015)
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CSCL 03B

The HERS detector of the Ion Mass Spectrometer on the Giotto spacecraft measured the 3 dimensional distribution of picked-up cometary protons over a distance of 6 million km upstream of the bow shock. The protons are elastically scattered out of their original cycloidal trajectories such that they are nonuniformly distributed over a spherical shell in velocity space. The shell thickness increases as the bow shock is approached. Inside the shock, the cometary protons are difficult to distinguish from the heated solar wind protons. ESA

N87-25144# Mullard Space Science Lab., Dorking (England).
VARIATIONS IN THE SOLAR WIND FLOW DURING THE APPROACH TO COMET HALLEY c93
A. D. Johnstone, A. J. Coates, J. Heath, M. F. Thomsen, B. Wilken, K. Jockers, V. Formisano, E. Amata, J. D. Winningham, H. Borg (Kiruna Geophysical Inst., Sweden) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 25-27 (For primary document see N87-25141 18-90)
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The Giotto spacecraft was operated almost continuously at a high telemetry rate for over 40 hr before Halley encounter. This enabled the plasma analyzer to make continuous detailed observations of the solar wind ion distribution (protons and alpha particles) with a time resolution of a 8 sec from a distance of over 10 million km. Many fluctuations occur in the density, velocity, and temperature of the flow over a wide frequency range. Data from a distance of 5 million km to the cometary foreshock distinguish the contribution produced by the interaction between implanted cometary ions and the solar wind, and reveal the characteristics of the waves. ESA

N87-25145*# Centre d'Etude Spatiale des Rayonnements, Toulouse (France).
GENERAL FEATURES OF THE COMET HALLEY-SOLAR WIND INTERACTION FROM PLASMA MEASUREMENTS
H. Reme, J. A. Sauvaud, C. dUston, A. Cros, K. A. Anderson, C. W. Carlson, D. W. Curtis, R. P. Lin, A. Korth, A. K. Richter (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 29-34 Original contains color illustrations (For primary document see N87-25141 18-90)
(Contract NASw-3575; Grants CNES-1212; BMFT-01-OF-052)
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The Giotto Complete Positive ion, Electron and Ram Negative Ion measurements near Comet Halley plasma experiment identified regions in which the solar wind interaction with the cometary plasma displayed characteristic features. Beginning 4.6 million km from the comet there is an upstream region with sporadic connection to the comet. An electron foreshock is present up to 250,000 km away from the bow shock. A bow shock is detected at 1.15 million km. Between the bow shock and the cometopause the outer regions can be divided into three parts. A cometopause is found at 135,000 km, and a density decrease is detected at 45,000 km from the comet. The detailed plasma features associated with these regions are described. ESA

N87-25146# Cologne Univ. (West Germany). Inst. fuer Geophysik und Meteorologie.
GIOTTO MAGNETIC FIELD RESULTS ON THE MAGNETIC FIELD PILE-UP REGION AND THE CAVITY BOUNDARIES
F. M. Neubauer *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 35-41 Sponsored by BMFT (For primary document see N87-25141 18-90)
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Investigations of the inner plasma boundaries in the magnetoplasma surrounding comet Halley during the encounter of the Giotto spacecraft are summarized. The magnetic pile-up region boundary has a stand-off distance in the direction opposite to the aberrated solar wind between 143,000 and 215,000 km depending on the assumed flaring. The axis of symmetry has an offset of 80,000 km from the nucleus. The ionopause, i.e., the outer boundary of the magnetic cavity region has either a smooth surface of radius 4600 km displaced from the nucleus by 1400 km or, alternatively, has no average displacement but strong ripples aligned with the aberrated solar wind direction, a wavelength of at least 200 km and a radius of approximately 4300 km. ESA

N87-25147# Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany).
MHD-MODEL FOR COMET HALLEY
H. U. Schmidt, R. Wegmann, and F. M. Neubauer (Cologne Univ., West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 43-46 (For primary document see N87-25141 18-90)
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A three-dimensional MHD model for a Halley type comet is compared with the magnetic field measurements of the Giotto spacecraft. The model takes into account the inclined interplanetary field, the net effect of mass loading by ionization of the cometary gases, the elastic collisions between neutrals and ions, and the Lorentz-forces of the piled up magnetic field. ESA

N87-25148*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PLASMA STRUCTURES IN COMET HALLEY

John C. Brandt and Malcolm B. Niedner, Jr. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 47-52 (For primary document see N87-25141 18-90)

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Large-scale plasma phenomena based on results of spacecraft probing of comets Halley and Giacobini-Zinner and on International Halley Watch are discussed. The data show that: the basic mechanism for the comets' interaction with the solar wind (Alfven, 1957) is correct; that the turn-on and turn-off of plasma activity follows the description of Mendis and Flammer (1984); and that disconnection events are associated with sector boundary crossings and an essential element in the morphology of developed plasma tails (Niedner and Brandt, 1978). ESA

N87-25149# Ruhr Univ., Bochum (West Germany). Inst. fuer Astronomie.

THE ACCELERATION WITHIN THE PLASMA TAIL, THE ROTATIONAL PERIOD OF THE NUCLEUS AND THE ABERRATION OF THE PLASMA TAIL OF COMET P/HALLEY 1986

W. E. Celnik *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 53-58 (For primary document see N87-25141 18-90)

(Grant DFG-Ce-21/1-1)

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Comet P/Halley was observed photographically from Feb 17 to Apr 17, 1986; 125 widefield camera images were used to study the dynamics within the plasma tail. Velocity and acceleration along the tail were determined from 122 tail condensations. During the observational campaign the mean acceleration was 43 + or - 2 cm/sec/sec. Variations of the acceleration with respect to the distance from the nucleus and to heliocentric distance were measured. The motions of the condensations were followed back in time to obtain the time of zero distance from the nucleus. The mean time interval between these starting dates is 53.5 + or - 1.7 hr, which is interpreted as the rotational period of the nucleus. The mean aberration angle of the plasma tail during the observational period was + 1.8 + or - 0.3 deg. Mean coma diameter in the CO(+) filter used was 750,000 km, + or - 150,000 km. ESA

N87-25150# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).

NARROW-BAND FILTER OBSERVATIONS OF COMET HALLEY DURING A TAIL DISCONNECTION

K. Jockers, E. H. Geyer, H. Rosenbauer, and A. Haenel (Observatorium Hoher List, Bonn, West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 59-61 (For primary document see N87-25141 18-90)

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On April 11, 1986, between 0045 and 1008 UT 37 exposures of comet Halley were obtained with a focal reducer attached to the 1m telescope of the European Southern Observatory. The pictures have a field of 30 arcmin and, with few exceptions, were taken in 1 nm wavelength bands centered at 367.4 and 425.2 nm to show the CO2(+) and CO(+) ion tail. The narrow wavelength band suppresses the coma efficiently and allows to study the cometary plasma particles much closer to the nucleus than previously possible. On April 11 the comet was very active and a tail disconnection occurred. The observed plasma motions confirm results of earlier studies but the relation between tail ray formation and kinks in the main tail can be more clearly established. No plasma envelopes are detected on the images. The appearance of tail rays is preceded by a rapid ejection of a diffuse cloud into the direction of the rays. ESA

N87-25151# Central Research Inst. for Physics, Budapest (Hungary).

PLAZMAG-1 EXPERIMENT: SOLAR WIND MEASUREMENTS DURING THE CLOSEST APPROACH TO COMET GIACOBINI-ZINNER BY THE ICE PROBE AND TO COMET HALLEY BY THE GIOTTO AND SUISEI SPACECRAFT c92

I. Apathy, A. P. Remizov, K. I. Gringauz, V. M. Balebanov, I. Szemerey, S. Szendroe, T. Gombosi, I. N. Klimenko, M. I. Verigin, E. Keppler (Academy of Sciences, USSR, Moscow) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 65-70 (For primary document see N87-25141 18-90)

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The PLAZMAG-1 plasma analyzer, flown on the VEGA 1 and VEGA 2 spacecraft, is described. When the spacecraft approached comet Halley, the instrument produced information on the plasma phenomena around the comet. The sensors determine: basic parameters of solar wind protons and alpha particles, using the ion energy spectrometer, viewing towards the Sun; mass composition of cometary ions, using the ion mass spectrometer, oriented along the spacecraft-comet relative velocity vector (vrv); electron energy distribution, using the electron energy spectrometer, oriented perpendicular to the direction towards the Sun and to the vrv vector; solar wind ion flux, using the integral counter, oriented towards the Sun; and number density of cometary ions and neutral particles, using the integral counter, and PID, oriented along the vrv vector. ESA

N87-25152# Tokyo Univ. (Japan). Inst. of Space and Astronomical Science.

PLASMA CHARACTERISTICS AROUND COMET HALLEY OBSERVED BY SUISEI

T. Mukai, M. Kitayama, W. Miyake, T. Terasawa, and Kunio Hirao (Tokai Univ., Kanagawa, Japan) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 71-75 Original contains color illustrations (For primary document see N87-25141 18-90)

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Plasma observations from Suisei clearly demonstrate the existence of the shell structure in the phase-space distribution of cometary ions as evidence of the pickup process in the upstream solar wind as well as inside the cometosheath. The observed spatial distribution of water-group ions is most consistently interpreted taking the water-production rate of 2 times 10 to the 30th power/sec. The model calculation shows inbound-outbound asymmetry in the density of cometary ions in good agreement with the observation. It is suggested that this asymmetry is caused mainly by the difference of orbital conditions between the inbound and outbound orbits in reference to the comet. ESA

N87-25153# Centre d'Etude Spatiale des Rayonnements, Toulouse (France).

DESCRIPTION OF THE MAIN BOUNDARIES SEEN BY THE GIOTTO ELECTRON EXPERIMENT INSIDE THE COMET HALLEY-SOLAR WIND INTERACTION REGIONS

C. dUston, H. Reme, J. A. Sauvaud, A. Cros, K. A. Anderson, C. W. Carlson, D. Curtis, R. P. Lin, A. Korth, A. K. Richter (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany) et al. *In* ESA Proceedings of the 20th ESLAB

Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 77-80 (For primary document see N87-25141 18-90)
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The Giotto electron plasma experiment identified several boundaries inside the comet Halley-solar wind region. Two of them are particularly interesting; they separate very different plasma regimes on quite sharp length scales and their existence was not foreseen in theoretical models. They are: the limit between the transition region and the sheath detected at 550,000 km from the nucleus; and the cometopause detected at 135,000 km from the nucleus. Characteristic features of the electron distribution functions and of the macroscopic parameters of the electron plasma through these main boundaries are described. ESA

N87-25154*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE P/GIACOBINI-ZINNER MAGNETOTAIL
J. A. Slavin, E. J. Smith, P. W. Daly, K. R. Flammer (California Univ., San Diego, La Jolla), G. Gloeckler, B. A. Goldberg, D. J. McComas, F. L. Scarf (Observatoire de Paris-Meudon, France), and J. L. Steinberg *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 81-87 (For primary document see N87-25141 18-90)
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CSCL 03B

On September 11, 1985 the International Cometary Explorer (ICE) passed behind comet Giacobini-Zinner with a closest approach distance of 7800 km. In agreement with Alfven's interplanetary magnetic field line draping model of cometary type 1 tails, a well defined 10,000 km diameter magnetotail was observed downstream of the inner coma. The ICE magnetic field, plasma electron, plasma wave, and energetic ion observations are used to investigate the structure and stability of the Giacobini-Zinner magnetic tail. Cometary and planetary magnetotails are compared. The ICE magnetotail observations are discussed in relation to the global solar wind interaction with P/Giacobini-Zinner. ESA

N87-25155# Polish Academy of Sciences, Warsaw. Space Research Center.
PLASMA WAVES IN HALLEY'S INNER COMA AS MEASURED BY THE APV-N EXPERIMENT DURING VEGA MISSION
P. Oberc, D. Orlowski, R. Wronowski, S. Klimov, and S. Savin (Academy of Sciences, USSR, Moscow) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 89-92 (For primary document see N87-25141 18-90)
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Measurements of electric field spectral density in 10 Hz to 1 kHz frequency range in Halley's inner coma are discussed. At distances between 600,000 and 300,000 km from the nucleus the ambient plasma waves are strongly disturbed by interference with the signals produced by gas leakage from the infrared spectrometer. At smaller distances the wave amplitudes exceed the interference level enabling the continuous measuerement of the increasing wave activity. Significant changes of the plasma wave spectra take piace in the heavy ion mantle and in the cometary plasma region. Three characteristic peaks: at 7 to 23 Hz, 170 to 430 Hz, and 950 Hz, are identified in the spectra obtained near the closet approach. There are considerable differences between the APV-N measurements aboard Vega 1 and Vega 2. Comparison with the APV-V results suggests that plasma wave amplitude exceeded the dynamic range of APV-N aboard Vega 2. ESA

N87-25156# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
COMETARY PLASMA REGION IN THE COMA OF COMET HALLEY: VEGA-2 MEASUREMENTS
K. I. Gringauz, M. I. Verigin, A. K. Richter, T. I. Gombosi, K. Szegoe, M. Tatrallyay, A. P. Remizov, and I. Apathy (Central Research Inst. for Physics, Budapest, Hungary) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 93-97 (For primary document see N87-25141 18-90)
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Based on the measurements of the CRA electrostatic analyzer of the PLASMAG-1 instrument, which was oriented along the spacecraft-comet relative velocity direction, observations of the cometopause, of quasi-periodic features occurring in the ion intensity inside the cometopause, of the mass composition of cometary ions between 1 and 100 amu in the cold and slowly moving plasma, and of the radial dependence of the density of certain groups of cometary ions are presented. The ion measurements are corrected for the nonlinear effects in the channeltron counting rates close to the encounter. At a few tens of thousands of km from the nucleus, 70% to 80% of the ion content belongs to the H2O group, 15% to 20% stems from the CO/CO2 group, and 2% to 5% has a mass of 44 (CO_2^+). The ratios are in reasonable agreement with those measured by the PICCA and by the IMS instruments on board Giotto. ESA

N87-25157*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE COMPOSITION AND DYNAMICS OF COMETARY IONS IN THE OUTER COMA OF HALLEY
H. Balsiger, K. Altwegg, F. Buehler, S. A. Fuselier, J. Geiss, R. Goldstein, A. J. Lazarus, A. Meier, M. Neugebauer, U. Rettenmund (Bern Univ., Switzerland) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 99-103 Sponsored by NASA, BMFT, and the Swiss National Science Foundation (For primary document see N87-25141 18-90)
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During its flyby at comet Halley, Giotto encountered high densities of cometary ions inside 200,000 km from the nucleus. Their properties changed drastically as the comet was approached. Density profiles of solar wind alpha particles and of the major cometary ions as obtained by the IMS-HERS sensor between 340,000 and 60,000 km from the nucleus are shown. Typical mass spectra at various distances are presented, and angular and velocity distributions of the cometary ions are discussed. ESA

N87-25158*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
OBSERVATIONS OF HEAVY ENERGETIC IONS FAR UPSTREAM FROM COMET HALLEY
T. R. Sanderson, K.-P. Wenzel, P. W. Daly, S. W. H. Cowley, R. J. Hynds, I. G. Richardson, E. J. Smith, S. J. Bame, and R. D. Zwickl (Los Alamos Scientific Lab., N. Mex.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 105-108 (For primary document see N87-25141 18-90)
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On March 25, 1986, when the ICE spacecraft came within 28 million km of the nucleus of comet Halley, and for several days around this time, bursts of heavy ions were observed by the ICE energetic ion experiment. The bursts were observed only during periods when the solar wind velocity was considerably higher than its nominal value. The characteristics of these ions, in particular their anisotropies, were examined. Using the well known formulae for transformation of distributions from the solar wind frame of reference to the spacecraft frame, the angular distributions expected from either protons, or heavy ions from the water group, were studied, showing that the measurements are consistent with

heavy ions, and not with protons. Other sources of heavy ions are considered, and the most likely source of these ions is comet Halley. ESA

N87-25159# Central Research Inst. for Physics, Budapest (Hungary).
ENERGETIC PICK-UP IONS OUTSIDE THE COMET HALLEY BOW SHOCK
K. Kecskemety, T. E. Cravens, V. V. Afonin, G. Erdoes, E. G. Eroshenko, L. Gan, T. I. Gombosi, K. I. Gringauz, E. Keppler, I. N. Klimenko (Academy of Sciences, USSR, Moscow) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 109-114 (For primary document see N87-25141 18-90)
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The TUNDE-M experiment on Vega-1 detected energetic cometary ions as far as 10 million km from comet Halley. The measured ion fluxes increase as the radial distance to the nucleus decreases. Sharp enhancements spaced at 4hr intervals are superimposed on the general increase of the ion fluxes on the inbound leg of Vega-1. No obvious correlations between the ion fluxes and the interplanetary field direction are found. Distribution functions in the solar wind reference frame were derived from measured counting rates. The distributions are approximately Maxwellian for energies about 100 keV and the derived temperatures vary from 20 keV for large radial distances (r = 10 million km) to 4 keV at 1.5 million km before the bow shock (r = 2.5 million km). ESA

N87-25160# Tohoku Univ., Sendai (Japan). Inst. of Geophysics.
INTERACTION PROCESSES OF COMETARY PLASMA WITH THE SOLAR WIND PLASMA IN REGIONS REMOTE FROM THE NUCLEUS OF THE COMETS HALLEY AND GIACOBINI-ZINNER
H. Oya *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 117-127 (For primary document see N87-25141 18-90)
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Observations made by using energetic particles, plasma waves, and the magnetic field detectors onboard Sakigake, Suisei, and ICE spacecraft reveal widely distributed plasma turbulences in the region remote from nucleus of comets Halley and Giacobini-Zinner. The turbulences contain the ion cyclotron mode, lower hybrid mode, electron cyclotron mode, whistler mode, quasi-whistler mode, and electron acoustic mode waves. The turbulences are directly associated with the ion pick-up phenomena, as verified by the observations of the particle behavior. The turbulent regions show remarkable asymmetry of the distribution; the region is expanded by 2 or 3 times larger in the side of the postencounter compared with the side of the pre-encounter, in the range from 7 to 10 million km. The expansion of asymmetry of the plasma region is interpreted in terms of the friction of the cometary plasma with the solar wind plasma. It is suggested that the concept of ion pick-up should be changed from the simple gyro-motion model to the turbulent friction model. ESA

N87-25161# Onagawa Magnetic Observatory (Japan).
QUASI-PARALLEL MODEL FOR COMET HALLEY NEAR THE ENCOUNTER OF SAKIGAKE
Takao Saito, Kiyohumi Yumoto, Kunio Hirao, Tomoko Nakagawa, and Keiji Saito (Hosei Univ., Tokyo, Japan) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 129-133 (For primary document see N87-25141 18-90)
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The solar wind magnetic field was observed continuously from 19 February 1985 by a triaxial ring-core magnetometer on board Sakigake. As expected from the two-hemisphere model, the tilt angle of the heliospheric neutral sheet decreased gradually during the transition from excursion phase to aligned phase. Near the encounter of Sakigake with Comet Halley (10-12 March 1986), the magnetometer detected clear multiple crossings of the nearly horizontal heliospheric neutral sheet. Although comet Halley was to cross the same neutral sheet 4 hr later, there was no apparent disconnection event (DE) in its ion tail during 11-12 March. The observed sheet-tail interaction is explained by a quasi-parallel model so that the ion tail does not always show a DE when a comet crosses the heliospheric neutral sheet that is nearly parallel to the tail axis. ESA

N87-25162# Onagawa Magnetic Observatory (Japan).
EFFECT OF THE HELIOSPHERIC NEUTRAL SHEET TO THE KINKED ION TAIL OF COMET HALLEY ON 13 MAY 1910
Takao Saito and Keiji Saito (Hosei Univ., Tokyo, Japan) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 135-140 (For primary document see N87-25141 18-90)
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Surveying 26 plates of comet Halley during the apparition in 1910, the ion tail with a distinct kink on May 13 is concluded to be one of the most specific events throughout the last apparition. The heliosphere was deduced from the analysis of its solar cycle variation to be in excursion phase. From the analysis of 27-day recurrence time pattern of geomagnetic activity index C9 during 1909-1911, the inclination and the position of the heliospheric neutral sheet on the day is obtained and expressed on the two-hemisphere diagram. Superposition of the Earth and the comet on the diagram reveals that the comet was just on the neutral sheet on 13 May 1910. Considering the observation by Sakigake on the deflection of the solar wind near the neutral sheet, it is concluded that the kink of the ion tail is caused by a sector boundary crossing. The sector boundary-ion tail interaction is also studied for two other cometary cases of Bennett, and Tomita-Gerber-Honda. ESA

N87-25163# Lund Observatory (Sweden).
TWO DISCONNECTION EVENTS IN COMET HALLEY, APRIL 1986
Henrik Lundstedt and Per Magnusson (Uppsala Ionospheric Observatory, Sweden) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 141-143 (For primary document see N87-25141 18-90)
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Disconnection events (DE) in comet Halley in April 1986 were observed from La Palma, Canary Islands, and from Australia in order to get as long time coverage as possible. The 3D heliospheric current sheet was modelled from large scale solar magnetic field observations. A current sheet's crossing of the comet is suggested for the DE of 13/14 April 1986. Two days earlier another DE occurred. At that time no polarity change was observed but instead a strong compression region in the solar wind. For this DE of 11/12 April, the interaction region between slow and fast solar wind is suggested as the cause. ESA

N87-25164*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HIGH-RESOLUTION IMAGING STUDIES OF THE NEAR-NUCLEUS REGIONS OF COMETS
B. A. Goldberg, J. A. Slavin, I. Halliday, B. A. McIntosh, G. C. L. Aikman, and A. F. Cook (Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.) *In* ESA Proceedings or the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 153-156 Sponsored by the Canada-France-Hawaii Telescope Corporation, and the Canadian National Research Council Original contains color illustrations (For primary document see N87-25141 18-90)
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CSCL 03B

High-resolution, calibrated images of the near-nucleus regions of Halley, Giacobini-Zinner (for ICE encounter) and additional comets displaying widely differing levels of activity were acquired with a CCD sensor at the Cassegrain focus of the 3.6 m Canada-France-Hawaii Telescope (CFHT). The International Halley Watch designated interference filters were used. Successful correlation of ICE magnetic field data with the optical images obtained with the CFHT on the night of encounter (11 Sept. 1985) primarily through the H2O(+) and neighboring continuum passbands and with 300 km spatial resolution provokes reinterpretation of the observed structure of cometary ion tails. The observations of Halley, limited by bad weather, were made at significant periods of the apparition: the first, in December 1984 with the comet at 5.3 AU during the period of the onset of activity; and the last, in November 1985 with the comet near opposition. The December observations show evidence of residual activity. The 18 November data show a highly-condensed inner coma with an extreme falloff in brightness from the region of the nucleus. These data provide the basis for characterizing the gas and dust environment in the immediate vicinity of the active nucleus. ESA

N87-25165# Ceskoslovenska Akademie Ved, Ondrejov. Inst. of Astronomy.

ANALYSIS OF SOLAR ACTIVITY DURING THE PERIOD OF HALLEY ENCOUNTER c92

B. Valnicek *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 157-159 (For primary document see N87-25141 18-90)

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Chromospheric flares and coronal holes occurring during Halley encounter are discussed. Chromospheric flares are sources of X and UV radiation, and coronal holes are regions of solar wind emission. The X and UV radiation can influence the comet only if the source is directly visible on the solar disk. Charged particles of solar wind move in an orbit which has the form of an Archimedes spiral and this makes possible influence from sources that are up to 40 deg behind the visible solar limb. ESA

N87-25166*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

OBSERVATIONS OF COMETARY PLASMA WAVE PHENOMENA

F. L. Scarf, F. V. Coroniti, C. F. Kennel, D. A. Gurnett, W.-H. Ip (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany), and E. J. Smith *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 163-168 (For primary document see N87-25141 18-90)

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The ICE plasma wave investigation utilized very long electric antennas (100 m tip-to-tip) and a very high sensitivity magnetic search coil to obtain significant local information on plasma physics phenomena occurring in the distant pickup regions of Comet Giacobini-Zinner and Comet Halley; and information on the processes that developed in the coma and tail of Giacobini-Zinner. The ICE plasma wave measurements associated with both comet encounters are summarized, and high sensitivity ICE observations are related to corresponding measurements from the other Halley spacecraft. ESA

N87-25167# Academy of Sciences (USSR), Moscow. Inst. of Space Research.

CHARACTERISTIC FEATURES OF THE COMETOSHEATH OF COMET HALLEY: VEGAS-1 AND VEGA-2 OBSERVATIONS

M. I. Verigin, K. I. Gringauz, A. K. Richter, T. I. Gombosi, A. P. Remizov, K. Szegoe, I. Apathy, I. Szemerey, M. Tatrallyay (Central Research Inst. for Physics, Budapest, Hungary), and L. A. Lezhen *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 169-173 (For primary document see N87-25141 18-90)

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Based on the PLASMAG-1 measurements on board Vega-1 and 2 it is shown that besides the deceleration and thermalization of the solar wind plasma behind the bow shock, two clearly separated populations of cometary ions are observed in the cometosheath region. The first consists of ions being picked up in the vicinity of the point of observation. The energy of these ions coming from the solar direction decreases much faster than the energy of the solar wind ions. The second consists of cometary ions being picked up by the solar wind far away from the point of observation. Considerable oscillations in the plasma flow direction occur in the cometosheath region. ESA

N87-25168*# Centre de Recherches en Physique de l'Environnement, Saint Maur des Fosses (France).

ANGULAR AND ENERGY DISTRIBUTION OF LOW ENERGY COMETARY IONS MEASURED IN THE OUTER COMA OF COMET HALLEY

J. J. Berthelier, J. M. Illiano, R. R. Hodges, D. Krankowsky, P. Eberhardt, P. Laemmerzahl, J. H. Hoffman, I. Herrwerth, J. Woweries, U. Dolder (Bern Univ., Switzerland) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 175-178 Original contains color illustrations (For primary document see N87-25141 18-90)

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During the early phase of the Giotto encounter with comet Halley, at distances from the nucleus > 350,000 km, the neutral mass spectrometer was operated in a mode allowing the measurement of low energy ions. Data reveal two important features of the outer coma: the presence of a sharp discontinuity in the plasma flow at 550,000 km from the nucleus which results in a significant decrease of the plasma flow accompanied by an increase in temperature; and the detection of newly born ions identified as O(+) and CO(+), at distances from the comet > 800,000 km. ESA

N87-25169*# Max-Planck-Inst. fuer Kernphysik, Heidelberg (West Germany).

EXPANSION VELOCITY AND TEMPERATURES OF GAS AND IONS MEASURED IN THE COMA OF COMET HALLEY

P. Laemmerzahl, D. Krankowsky, R. R. Hodges, U. Stubbemann, J. Woweries, I. Herrwerth, J. J. Berthelier, J. M. Illiano, P. Eberhardt, U. Dolder (Bern Univ., Switzerland) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 179-182 (For primary document see N87-25141 18-90)

(Contract NASw-3576; Grants BMFT-01-OF-0519; BMFT-01-OF-0928; BMFT-01-OF-85120; SNSF-2.034-0.81; SNSF-2.825-85; CNES-81,82/244; CNES-83/211; CNES-84,85/1211)

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In situ measurements of flow velocity and temperature in the inner coma were obtained from ram energy spectra of molecules and ions observed by the Giotto neutral mass spectrometer. Radial flow speed is 800 km/sec; near 2,500 km from the nucleus increasing to more than 1000 m/sec at 20,000 km. A near zero volt spacecraft potential was inferred. Ion temperatures are approx. 200 K inside the contact surface (approx. 4500 km) where the plasma is collisionally coupled to the gas; at this boundary ion temperature rises by approx. 1000 K. The observations indicate a heat source which is effective to large distances. ESA

N87-25170# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
DISTRIBUTION OF COMETARY IONS AND FLOW PROPERTIES IN HALLEY'S COMET
G. Zastenker, O. Vaisberg, V. Smirnov, A. Fedorov, and A. Omelchenko *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 183-188 (For primary document see N87-25141 18-90)
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Radial profiles of heavy cometary ions were obtained with BD-3 plasma detector on Vega-1 and 2. Cometary mantle has relatively sharp outer boundary at approx. 150,000 km and steeper than R(-2) density profile. Large-scale density enhancements (approx. 30,000 km) and small-scale ones (250 to 1000 km) were observed. Local maximum approx. = 4000/cc at approx. 12,000 km suggests ion pile-up between two flows. Nearly antisolar component of plasma velocity is approx. 20 km/sec at approx. 60,000 km, and decreases to approx. 5 km/sec at approx. 25,000 km. Ion density decrease by factor of 3 or compression of plasma mantle occurred within 3 days between Vega-1 and Vega-2 flybys. ESA

N87-25171# Academy of Sciences (USSR), Troitsk. Inst. of Terrestrial Magnetism: Ionosphere and Radiowave Propagation
MAGNETIC FIELD FINE STRUCTURE IN COMET HALLEY'S COMA
Ye. G. Yeroshenko, V. A. Styashkin, W. Riedler, K. Schwingenschuh, and C. T. Russell (California Univ., Los Angeles.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 189-192 (For primary document see N87-25141 18-90)
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During the encounter with comet Halley magnetic field measurements aboard Vega-1 and Vega-2 revealed short magnetic field depressions (MFD) at times of a generally rather smooth rise or fall of the magnetic field. A maximum MFD magnitude of 40 nT and a maximum duration of 50 sec are observed at distances of 50,000 to 70,000 km. These events are due to spatial plasma irregularities inside the coma region and not to temporal field variations. The observed effects may be caused by cometary plasma rays. ESA

N87-25172# Academy of Sciences (USSR), Moscow. Inst. of Space Research
ELECTRON COMPONENT OF THE PLASMA AROUND HALLEY'S COMET MEASURED BY THE ELECTROSTATIC ELECTRON ANALYZER OF PLASMAG-1 ONBOARD VEGA-2
K. I. Gringauz, A. P. Remizov, M. I. Verigin, A. K. Richter, M. Tatrallyay, K. Szegoe, I. N. Klimenko, I. Apathy, T. I. Gombosi, and T. Szemerey (Central Research Inst. for Physics, Budapest, Hungary) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 195-198 (For primary document see N87-25141 18-90)
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Measurements of the electron spectra obtained by Vega-2 in the vicinity of comet Halley are presented. It is shown that the temperature of thermal electrons decreases from about 400,000 K shortly behind the bow shock to 200,000 K at the cometopause. Inside the cometopause a fast increase in the flux of energetic electrons of 1 keV is observed. Possibilities for the differences in the electron spectra measured by Vega-2 and by Giotto are discussed. ESA

N87-25173*# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).
RADIAL VARIATIONS OF FLOW PARAMETERS AND COMPOSITION OF COLD HEAVY IONS WITHIN 50,000 KM OF HALLEY'S NUCLEUS
A. Korth, A. K. Richter, D. A. Mendis, K. A. Anderson, W. Carlson, D. W. Curtis, R. P. Lin, D. L. Mitchell, H. Reme, J. A. Sauvaud (Centre d'Etude Spatiale des Rayonnements, Toulouse, France) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 199-201 Sponsored in cooperation with Max-Planck Gesellschaft zur Foerderung der Wissenschaften e.V. Original contains color illustrations (For primary document see N87-25141 18-90)
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Composition and flow parameter of cold heavy ions from the PICCA instrument on Giotto within a cometocentric distance of 50,000 km are presented. A distinct boundary at about 27,000 km, where the flow parameters changed abruptly, is identified and its physical significance is discussed. Radial profiles of heavy ion groups and abundance ratios are given. ESA

N87-25174*# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany). Space Sciences Lab.
DERIVATION OF HEAVY (10-210 AMU) ION COMPOSITION AND FLOW PARAMETERS FOR THE GIOTTO PICCA INSTRUMENT
D. L. Mitchell, R. P. Lin, K. A. Anderson, C. W. Carlson, D. W. Curtis, A. Korth, A. K. Richter, H. Reme, J. A. Sauvaud, C. dUston (Centre d'Etude Spatiale des Rayonnements, Toulouse, France) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 203-205 (For primary document see N87-25141 18-90)
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The Giotto heavy ion analyzer RPA2-PICCA was designed to identify the composition and distribution of heavy thermal positive ions in the coma of comet Halley. The instrument is an electrostatic analyzer which takes advantage of the large relative flyby velocity and the fact that the ions in the inner coma should be cold and predominantly singly charged. A method of deconvolving E/Q measurements to yield ion mass composition, temperature, and flow velocity is presented. The measurements are used to investigate the dynamic behavior of the ions and variations in mass composition as a function of cometary distance. ESA

N87-25175*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HOT IONS OBSERVED BY THE GIOTTO ION MASS SPECTROMETER INSIDE THE COMET HALLEY CONTACT SURFACE
R. Goldstein, D. T. Young, H. Balsiger, F. Buehler, B. E. Goldstein, M. Neugebauer, H. Rosenbauer, R. Schwenn, and E. G. Shelly (Lockheed Aircraft Corp., Palo Alto, Calif.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 207-211 (For primary document see N87-25141 18-90)
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Just inside the contact surface (approx. 4700 km) the High Energy Range Spectrometer (HERS) sensor of the Giotto ion mass spectrometer detected a sudden, intense burst of ions that lasted until the HERS sensor ceased transmitting data at a distance 3000 km from comet Halley. During this interval ions with M/Q=1, 2, 12, 14, 16, 19, 24 and 28 were observed. The heavier ions appear in two populations (in the S/C frame): a very low energy, almost omnidirectional distribution, and a more energetic (approx. < ram speed) population coming from the ram direction. The low energy ions may belong to the natural Halley environment or be generated at the spacecraft by dust and gas bombardment. The ions may also be related to spacecraft charging processes on Giotto. ESA

N87-25176# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.

THE COMETOPAUSE REGION AT COMET HALLEY

E. Amata, V. Formisano, R. Cerulli-Irelli, P. Torrente, A. D. Johnstone, A. Coates, B. Wilken, K. Jockers, J. D. Winningham, D. Bryant (Southwest Research Inst., San Antonio, Tex.) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 213-218 (For primary document see N87-25141 18-90)

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Evidence that the cometopause region is bounded by the cometopause itself is presented. In the last part of the inbound Giotto trajectory, the JPA experiment observed 2 discontinuities not forecast by models: the first, at 23:30 GRT, characterized by a drop of solar wind speed and an increase of cometary ion count rate; the second, at 23:56 GRT, by the disappearance of the solar wind flow. Between the discontinuities solar wind protons are heated and cometary ions appear as a beam close to the ram direction with a large thermal spread; ions of different masses, up to the water-group, are seen at the same energy E approx. 400 eV. After the second discontinuity, all cometary ions have energies corresponding to the ram velocity. ESA

N87-25177*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

AN INTERPRETATION OF THE ION PILE-UP REGION OUTSIDE THE IONOSPHERIC CONTACT SURFACE

Wing-H. Ip, R. Schwenn, H. Rosenbauer, H. Balsiger, M. Neugebauer, and E. G. Shelley (Lockheed Aircraft Corp., Palo Alto, Calif.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 219-223 (For primary document see N87-25141 18-90)

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The possibility that the formation of the plasma pile-up region at comet Halley as observed by Giotto could be the combined result of field-aligned transport and recombination process is discussed. Giotto measurements support the hypothesis. ESA

N87-25178*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ION TEMPERATURE AND FLOW PROFILES IN COMET HALLEY'S CLOSE ENVIRONMENT

R. Schwenn, Wing-H. Ip, H. Rosenbauer, H. Balsiger, F. Buehler, R. Goldstein, A. Meier, and E. G. Shelley (Lockheed Aircraft Corp., Palo Alto, Calif.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 225-227 (For primary document see N87-25141 18-90)

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The Giotto high intensity spectrometer identified the contact surface 4800 km from the comet nucleus. This boundary is clearly seen by a drastic drop in the temperatures of different ion species from 2000 K outside to values as low as 300 K inside. Inside the contact surface outflow speed = > 1 km/sec, in contrast to a value around 0 right outside. These numbers might be affected by a potential charge-up of the spacecraft. Outside the contact surface, the ion temperature rises gradually with increasing distance. Between 9000 and 10,000 km distance the ion density increases by a factor of 4. At 27,000 km distance there is again a rather abrupt jump to significantly higher temperatures, higher outflow speeds, and lower densities. ESA

N87-25179*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

GIOTTO-IMS OBSERVATIONS OF ION FLOW VELOCITIES AND TEMPERATURES OUTSIDE THE CONTACT SURFACE OF COMET HALLEY

B. E. Goldstein, M. Neugebauer, H. Balsiger, J. Drake, S. A. Fuselier, R. Goldstein, Wing-H. Ip, U. Rettenmund, H. Rosenbauer, R. Schwenn (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 229-233 (For primary document see N87-25141 18-90)

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Fluid parameters for He(++) ions obtained from the Giotto ion mass spectrometer are presented. Proton densities and velocities and thermal speeds of protons, alpha particles, and heavy ions in the hour before closest approach are discussed. A region of enhanced He(++) ion densities, and velocity, and decreased temperature is observed from 20:26 to 21:45. Sharp decreases in the proton density are observed at 23:30 and at 23:41. There is a relative flow velocity between alpha particles and oxygen ions of 30 km/sec during a period from 22:55 to 23:30; the difference in flow velocity is less than the experimental uncertainities. The flow properties of protons observed during this period are also discussed. ESA

N87-25180*# Central Research Inst. for Physics, Budapest (Hungary).

A MODEL OF INNER COMETARY IONOSPHERES

A. Korosmezey, T. E. Cravens, T. I. Gombosi, A. F. Nagy, D. A. Mandis, K. Szegoe, B. E. Gribov, R. Z. Sagdeev, V. D. Shapiro, and V. I. Shevchenko (Academy of Sciences, USSR, Moscow) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 235-239 (For primary document see N87-25141 18-90)

(Grants NAGw-15; NGR-23-005-015; NSF INT-83-19732; NSF ATM-84-17884)

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CSCL 03B

A hydrodynamical model to describe the movement of the thermalized charged components in the inner ionosphere of comet Halley is presented. Photoelectrons are included by applying a two-stream-type approach. The numerical scheme describes shock transitions in a natural way. Solutions are obtained for a number of different assumptions concerning electron heating rates but all show that the electron temperature increases sharply where the collisional electron neutral coupling becomes unimportant. This temperature increase is accompanied by an increase in the plasma pressure and in its associated polarization electric field, and causes the plasma flow to go subsonic. In certain cases this transition occurs as an inner shock which may explain the observed ion pile-up in Halley's comet. ESA

N87-25181*# Michigan Univ., Ann Arbor. Space Physics Research Lab.

THE PHYSICS OF THE COMETARY CONTACT SURFACE

Thomas E. Cravens *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 241-246 (For primary document see N87-25141 18-90)

(Grants NAGw-15; NSF ATM-84-17884)

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The contact surface, which separates outflowing cometary plasma from solar wind controlled cometary plasma, is explained in terms of a balance between the magnetic pressure gradient force and ion-neutral drag. Giotto data indicate that the plasma pressure inside the contact surface cannot balance the sum of the external plasma and magnetic pressures, and therefore a Venus-like ionopause is not present at the contact surface. An expression for the magnetic field strength as a function of cometocentric distance is derived from the momentum equation. The theoretical magnetic field profile agrees quite well with the profile measured by the Giotto magnetometer in the vicinity of the contact surface. ESA

N87-25182# Onagawa Magnetic Observatory (Japan).
LONG-PERIOD HM WAVES ASSOCIATED WITH COMETARY O(+) (OR H2O(+)) IONS: SAKIGAKE OBSERVATIONS
Kiyohumi Yumoto, Tomoko Saito, and Takao Nakagawa *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 249-253 (For primary document see N87-25141 18-90)
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Long-period HM waves near the local water group ion cyclotron frequency were detected at the closest approach of Sakigake to comet Halley. These transverse waves having approx. 2 nT peak-to-peak amplitude (delta B) propagated approximately parallel to the ambient field. The necessary cometary pickup-ion density for excitation of the waves at 700,000 km upstream from the comet can be inferred to be on the order of 0.001/cu cm for 5 to 50 keV water group ions. Ring and shell formation, and thermalization times of newly created pickup-ion distributions are approx. 150, 100, and 4000 sec. respectively, for delta B/B sub 0 approx. 0.25 at 7 to 9 million km. These low-frequency HM waves are concluded to be excited by a resonant beam instability. ESA

N87-25183# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
FINE STRUCTURE OF THE NEAR-COMETARY BOW SHOCK FROM PLASMA WAVE MEASUREMENTS. (APV-N-EXPERIMENTS)
S. Klimov, A. Galeev, M. Nozdrachev, R. Sagdeev, S. Savin, V. Shapiro, A. Sokolov, and D. Orlowski (Polish Academy of Sciences, Warsaw.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 255-258 (For primary document see N87-25141 18-90)
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The structure of plasma waves in the near-cometary shock region was studied. Data on fluctuations of the electric field and the plasma flow ion component in the frequency range 1 to 1000 Hz with a time resolution of 12 sec were used. Characteristic spectra measured 1 million km from the comet indicate that Vega-1 crossed the quasi-perpendicular bow shock (BS) and Vega-2 the quasi-parallel shock. Precursors of the BS were observed in the frequency range 1.5 to 8.5 Hz with a modulation frequency of 20 min 6 to 8 hr before the BS crossing. At the shock front the level of magnetosonic oscillations increases near a low-hybrid frequency (LH) as well as in the intermediate frequency range between LH and electron-cyclotron frequencies. At the quasi-perpendicular BS front there is a drastic increase in the intensity within 1 to 450 Hz; at the quasi-parallel BS front, within 1 to 85 Hz. Mechanisms for generation of the waves are discussed. ESA

N87-25184*# California Univ., Berkeley. Space Sciences Lab.
THE UPSTREAM REGION, FORESHOCK AND BOW SHOCK WAVE AT HALLEY'S COMET FROM PLASMA ELECTRON MEASUREMENTS
K. A. Anderson, C. W. Carlson, D. W. Curtis, R. P. Lin, H. Reme, J. A. Sauvaud, C. dUston, A. Korth, A. K. Richter, and D. A. Mendis (California Univ., San Diego.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 259-261 Sponsored in cooperation with Gesellschaft zur Foerderung der Wissenschaften e.V. (For primary document see N87-25141 18-90)
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CSCL 03B

Halley plasma electron parameters from 2.7 million km from the comet nucleus to the bow shock wave at 1.1 million km and beyond are surveyed. The features of the electron foreshock lying outside the shock to a distance of 230,000 km are described. It is a region of intense solar wind-comet plasma interaction in which energetic electrons are prominent. Several spikes of electrons whose energies extend to 2.5 keV appear in front of the shock. These energetic electrons may be accelerated in the same way electrons are accelerated at the Earth's bow shock to energies of 1 to 10 keV. The direction of the electron bulk flow direction changes abruptly between 1920 and 1922 UT, and the flow speed begins a sharp decline at the same time. It is suggested that the spacecraft entered the bow shock wave between 1920 and 1922 UT. Electron density variations at Halley are very much smaller than those at Giacobini-Zinner. ESA

N87-25185# Mullard Space Science Lab., Dorking (England).
SOLAR WIND FLOW THROUGH THE HALLEY BOW SHOCK
c92
A. J. Coates, A. D. Johnstone, M. F. Thomsen, V. Formisano, E. Amata, B. Wilken, K. Jockers, J. D. Winningham, H. Borg, and D. A. Bryant (Science Research Council, Chilton, England) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 263-268 Original contains color illustrations (For primary document see N87-25141 18-90)
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The development of the density, temperature, and flow velocity of the solar wind ions at the inbound shock from the beginning of the foreshock region at 1825 SCET through to the sheath of Halley's comet is discussed, using Giotti data. The approach to the bow shock is marked by a series of waves of increasing amplitude in which the speed is reduced and the flow is deflected almost out of the field of view. There are several crossings of the boundary before the spacecraft enters the sheath for the last time. ESA

N87-25186# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
STOCHASTIC FERMI ACCELERATION OF IONS IN THE PRESHOCK REGION OF COMET HALLEY
B. E. Gribov, K. Kecskemety, R. Z. Sagdeev, Shapiro V. D., V. I. Shevchenko, A. J. Somogyi, K. Szegoe, G. Erdoes, E. G. Eroshenko (Academy of Sciences, USSR, Troitsk), K. I. Gringauz et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 271-275 (For primary document see N87-25141 18-90)
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Energetic cometary ion fluxes measured between 2.5 and 1 million km from the cometary nucleus along the inbound trajectory of Vega-1 are used to derive temperatures of the ion distributions in the solar wind frame. The increase of the temperatures is modeled by the temperature change derived from a Fokker-Planck type equation with a source term and a stochastic Fermi acceleration term. The temperature increase predicted by theory is approx. = 7 keV, considerably higher than the observed one (approx. 1.5 keV). The second order Fermi mechanism is shown to be capable of explaining the temperature increase; however, it is not clear whether the experimental uncertainties can account for the defect of the observed temperature or an unidentified cooling mechanism is at work. ESA

N87-25187# Kyoto Univ. (Japan). Inst. of Geophysics.
ION-PICKUP/MASS-LOADING PROCESS AROUND HALLEY OBSERVED BY SUISEI
T. Terasawa, S. Takahashi, W. Miyake, T. Mukai, M. Kitayama, and Kunio Hirao (Tokai Univ., Kanagawa, Japan) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 281-283 (For primary document see N87-25141 18-90)
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The interaction process of the solar wind with Halley cometary atmosphere is studied based on the plasma observation by Suisei. In the solar wind just upstream of the cometary bow shock, the thermal pressure of the cometary ions becomes comparable with that of the solar wind protons, so that the comeraty ions can

modify the shock condition significantly. Within the cometosheath, the temperature of solar wind protons decreases toward the closest approach. This temperature decrease is likely caused by the cooling effect accompanying the change exchange process with the cometary neutral molecules. ESA

N87-25188*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CHARGE EXCHANGE OF SOLAR WIND IONS IN THE COMET HALLEY COMA **c92**
E. G. Shelley, S. A. Fuselier, J. F. Drake, H. Balsiger, Wing-H. Ip (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany), B. E. Goldstein, R. Goldstein, and M. Neugebauer *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 285-289 Sponsored in cooperation with the BMFT and the Swiss National Science Foundation (For primary document see N87-25141 18-90)
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CSCL 03B

The He(2+) and He(+) radial profiles measured by the Giotto mass spectrometer on the inbound trajectory to comet Halley are compared to a simple 1-dimensional charge exchange model. Results indicate that charge exchange alone cannot account for the observed radial profiles of He(2+) and He(+). ESA

N87-25189# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).
ENERGETIC ELECTRON FLUXES (E(CH110)180 KeV) OBSERVED BY THE GIOTTO EXPERIMENT EPA DURING ENCOUNTER WITH COMET HALLEY
E. Kirsch, S. McKenna-Lawlor, A. Thompson, D. OSullivan, and F. M. Neubauer (Cologne Univ., West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 291-295 Sponsored in cooperation with the Max Planck Gesellschaft zur Foerderung der Wissenschaften e.V. and the National Board for Science and Technology, Ireland (For primary document see N87-25141 18-90)
(Grant BMFT-01-OF-082)
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The energetic particle detector system EPA/EPONA onboard Giotto detected ions and electrons with energies >20 keV in various energy channels. Electron fluxes are presented together with data from the Giotto magnetometer experiment. Electrons >180 keV were recorded from the transit of the foreshock, inbound, until the last observation outbound at 03:00 UT on 15 March 1986. Energy spectra for the inbound pass are shown. One flux enhancement in the >300 keV channel and several in the >180 keV channel were recorded outbound. Possible acceleration mechanisms for the energetic electrons are considered. ESA

N87-25190# Academy of Sciences, Berlin (East Germany). Inst. of Cosmic Research.
GASDYNAMIC INTERPRETATION OF ICE AND VEGA/GIOTTO/SUISEI PLASMA MEASUREMENTS
Th. Roatsch, K. Baumgaertel, and K. Sauer *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 297-300 (For primary document see N87-25141 18-90)
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The interaction of the solar wind with a cometary atmosphere is studied in the framework of a two-dimensional nonstationary gasdynamic model based on the approach of Biermann et al (1967). Its predictions are compared with plasma measurements of the ICE and the Vega Giotto Suisei spacecraft at their encounters with Giacobini-Zinner and Halley, respectively. Several of the observed large-scale flow features are well reproduced. ESA

N87-25191*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE COMET GIACOBINI-ZINNER MAGNETOTAIL: AXIAL STRESSES AND INFERRED NEAR-NUCLEUS PROPERTIES
D. J. McComas, J. T. Gosling, S. J. Bame, J. A. Slavin, E. J. Smith, and J. L. Steinberg (Observatoire de Paris-Meudon, France) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 301-304 Sponsored by NASA (For primary document see N87-25141 18-90)
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Utilizing the electron and magnetic field data from the ICE tail traversal of comet Giacobini-Zinner along with the MHD equations, a steady state, stress balance model of the cometary magnetotail was developed, and used to infer important but unmeasured ion properties within the magnetotail at ICE and upstream at the average point along each streamline where cometary ions are picked-up. The derived tailward ion flow speed at ICE is quite constant at approx. -20 to -30 km/sec across the entire tail. The flow velocity, ion temperature, density, and ion source rates upstream from the lobes (current sheet) at the average pick-up locations are approx. -75 km/sec (approx. -12), approx. 4 million K (approx. 100,000), approx. 20 cc (approx. 400), and approx. 15 cu cm/sec. Gradients in the plasma properties between the two regions are quite strong. Implications of inferred plasma properties for the near-nucleus region and for cometary magnetotail formation are examined. ESA

N87-25192# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).
ENERGETIC COMETARY WATER GROUP IONS AT HALLEY'S BOW SHOCK: OBSERVATIONS WITH THE GIOTTO ION SPECTROMETER IIS
B. Wilken, K. Jockers, W. Stuedemann, H. Rosenbauer, M. F. Thomson, A. Johnstone, A. Coates, V. Formisano, E. Amata, J. D. Winningham (Southwest Research Inst., San Antonio, Tex.) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 305-308 Original contains color illustrations (For primary document see N87-25141 18-90)
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Observations of cometary water group ions (A=16 to 18) at Halley's bow shock are presented. The analysis of the distribution function of heavy energetic pick-up ions shows that shell-like structures in velocity space exist. Quantitative figures for the shell filling factor are not available but there is evidence for substantial filling in the region upstream and inside the shock. Outside the bow shock the shell radius is equal to the local solar wind speed. The shell radius appears not to vary much as the spacecraft traversed the bow shock but the slowed down solar wind moved the shell across the spacecraft frame of reference. At the same time the temperature associated with the shell width increased from 5 million to 18 million K. ESA

N87-25193*# Arizona State Univ., Tempe. Dept. of Physics.
NEW MOLECULAR IONS IN SPECTRA OF COMET P/HALLEY
S. Wyckoff, P. A. Wehinger, Hyron Spinrad, and M. J. S. Belton (Kitt Peak National Observatory, Tucson, Ariz.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 311-316 (For primary document see N87-25141 18-90)
(Grant NAGw-547)
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Spectroscopic observations (4000 to 7000 A) were obtained of comet P/Halley near the time of the spacecraft encounters in March 1986. Molecular ion emission features were observed in the long-slit CCD spectra. Additional spectroscopic observations

obtained in April 1986 confirm the presence of many new ion features in the plasma tail. It is proposed that CO2(+) be identified with the new features in the 4000 to 4350 A region. The other unidentified ion features may be attributable to a single ion species. ESA

N87-25194*# McDonald Observatory, Austin, Tex.
HIGH RESOLUTIONS SPECTROSCOPY OF P/HALLEY
W. D. Cochran *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 317-321 (For primary document see N87-25141 18-90)
(Grant NGR-44-012-152)
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High resolution spectra of the coma of P/Halley were obtained on 25 April, 2 May, and 3 May 1986. The self-scanned Digicon detector of the 2.7 m telescope coude spectrograph was used to obtain spectra at a resolution of 0.6A. Results of the observation of the NH (A 3 Pi i yields X 3 Sigma (-)) band near 3360 A are presented. The summed NH spectrum represents the results of 190 min of integration centered on the nucleus of the comet. Eight rotational lines from the P and R branches of the band are detected. The lines from the Q branch are especially weak, and are not obviously resolved in the spectrum. The data are compared with the theoretical emission spectrum of Litvak and Kuiper (1982) and substantial discrepancies are found. These discrepancies are explained through a consideration of the relative timescales for collisions, resonance fluorescence, and radiative decays of the NH molecules in the coma. ESA

N87-25195*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
IUE OBSERVATIONS OF COMET HALLEY: EVOLUTION OF THE UV SPECTRUM BETWEEN SEPTEMBER 1985 AND JULY 1986
P. D. Feldman, Michael C. Festou, M. F. AHearn, C. Arpigny, P. S. Butterworth, C. B. Cosmovici, A. C. Danks, R. Gilmozzi, W. M. Jackson, L. A. McFadden (Maryland Univ., College Park.) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 325-328 (For primary document see N87-25141 18-90)
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The ultraviolet spectrum of comet P/Halley was monitored with the IUE between 12 September 1985 and 8 July 1986 (r $<$2.6 AU pre and post-perihelion) at regular time intervals except for a two-month period around the time of perihelion. A complete characterization of the UV spectrum of the comet was obtained to derive coma abundances and to study the light emission mechanisms of the observed species. The Fine Error Sensor (FES) camera of the IUE was used to photometrically investigate the coma brightness variation on time scales of the order of hours. Spectroscopic observations as well as FES measurements show that the activity of the nucleus is highly variable, particularly at the end of December 1985 and during March and April 1986. The production rates of OH, CS and dust are derived for the entire period of the observations. The total water loss rate for this period is estimated to be 150 million metric tons. ESA

N87-25196*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AIRBORNE INFRARED INVESTIGATION OF WATER IN THE COMA OF HALLEY'S COMET
Harold A. Weaver, Michael J. Mumma, Harold P. Larson, and D. Scott Davis (Arizona Univ., Tucson.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 329-334 (For primary document see N87-25141 18-90)
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An infrared Fourier transform spectrometer on the Kuiper Airborne Observatory (KAO) was used to obtain high resolution spectra of the intense, solar-pumped infrared fluorescent emission in the (001 to 000) band of H2O near 2.6 microns. Differences between the observed H2O excitation and original expectations are discussed, and KAO water production rates are compared to those derived from International Ultraviolet Explorer observations. Possible future directions for high resolution IR spectroscopy of comets are discussed. ESA

N87-25197*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
VELOCITY-RESOLVED OBSERVATIONS OF WATER IN COMET HALLEY
Harold P. Larson, D. Scott Davis, Michael J. Mumma, and Harold A. Weaver (Space Telescope Science Inst., Baltimore, Md.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 335-340 (For primary document see N87-25141 18-90)
(Grants NAG2-206; NAG2-356)
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An infrared spectrum of comet Halley was recorded at the Kuiper Airborne Observatory with an instrumental velocity resolution of 1.1 km/sec. A total of 13 emission lines in the 2.65 micron spectral region were assigned to neutral gaseous H2O : 10 in the 001 to 000 band and 3 in the hot 011 to 010 band. The position and widths of these lines are functions of the gas velocity field in the coma. Analysis indicates that the neutral gas outflow is widely dispersed about the nucleus. This spectroscopic picture is consistent with spacecraft images that show multiple jets releasing material into most of the sunfacing hemisphere. ESA

N87-25198*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE ORTHO/PARA RATIO OF WATER VAPOR IN COMET HALLEY
Michael J. Mumma, Harold P. Larson, and Harold A. Weaver (Space Telescope Science Inst., Baltimore, Md.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 341-346 (For primary document see N87-25141 18-90)
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The ortho/para ratio of H2O is shown to be an invariant in the cometary coma. The dependence of ortho-para ratio on temperature in thermal equilibrium is given, and the nuclear-spin-temperature is defined. Its relation to the physical temperature of the cometary ices is discussed, and the prospects for using the observed ortho/para ratio to infer properties of the cometary nucleus are explored. The ortho/para ratio in Halley's comet is derived from high resolution infrared spectra of near 2.7 microns wavelength. On UT December 24.1, 1985 it was 2.73 + or - 0.17, and on UT March 22.7, 1986 it was 3.23 + or - 0.37. The nuclear-spin-temperature was 35 K (+9 K, -5 K) pre-perihelion, and less than 40 K post-perihelion, at the 67% confidence limit. Both numbers are consistent with modeled values of the equilibrium temperature of the cometary nucleus at aphelion (47 K). However, at the 95% confidence limit they are also fully consistent with temperatures less than 50 K, corresponding to an ortho/para ratio of about 3.0. ESA

N87-25199*# Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
SEARCH FOR METHANE IN COMET HALLEY
S. Drapatz, Harold P. Larson, and D. Scott Davis (Arizona Univ., Tucson.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 347-352 (For primary document see N87-25141

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(Grant NAG2-206)
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A search for gaseous neutral CH4 was conducted in the coma of comet Halley on March 20, 1986 using a Fourier transform spectrometer on the Kuiper Airborne Observatory. In the field-of-view (24,000 km) the CH4 rotational temperature is equal to the kinetic temperature of the coma molecules due to collisions in most of the region and is frozen in at the outer edge. The spectrum of the nu3 band is due to fluorescence with the R(3) to R(5) lines being most suitable for Earth-based observations. Measured upper (3 delta) limits of 4 times 10 to the minus 19th power W/sqcm for these lines lead to a (7 delta) upper limit of 4 times 10 to the 28th power CH4 molecules per second. This value corresponds to 4% of the water vapor production rate at the time of observation. ESA

N87-25200# Observatoire de Paris-Meudon (France).
DETECTION OF PARENT MOLECULES IN COMET HALLEY FROM THE IKS-VEGA EXPERIMENT
M. Combes, V. Moroz, J. F. Crifo, J. P. Bibring, N. Coron, J. Crovisier, T. Encrenaz, N. Sanko, A. Grigoriev (Academy of Sciences, USSR, Moscow), D. Bockelee-Morvan et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 353-358 Sponsored by CNES (For primary document see N87-25141 18-90)
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Parent molecules were detected in comet Halley using the 2.5 to 5 microns channel of the IKS experiment aboard Vega 1. The spectral resolving power was 40 at 2.5 microns and 70 at 5 microns. The nu 3 band of H2O was observed at 2.7 microns, with an intensity corresponding to a production rate of 10 to the 30th power/sec. The nu 3 band of CO2 was detected at 4.3 microns; the derived CO2/H2O ratio is 0.015. There are emission features between 3.3 and 3.7 microns, which could be attributed to CH-bearing molecules. Other weaker spectral signatures are also tentatively identified. ESA

N87-25201# Institut d'Astrophysique, Paris (France).
THE SPECTRUM OF P/HALLEY BETWEEN 0.9 AND 2.5 MICRONS
J. P. Maillard, J. Crovisier, T. Encrenaz, and M. Combes (Observatoire de Paris-Meudon, France) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 359-364 (For primary document see N87-25141 18-90)
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High resolution Fourier transform spectra of comet Halley were recorded at the CFH 3.60m telescope (Hawaii) in December 1985 and April 1986. The spectral range is 0.83 to 2.6 microns. Bands of the CN red system are observed at 0.9 and 1.1 microns. An emission feature centered at 2.44 microns is identified as the nu 1 + nu 3-2 nu 4 band of H2O. Ground-based monitoring of this feature on future bright comets might be a direct method for measuring their H2O production rate. ESA

N87-25202# Observatoire de Paris-Meudon (France).
A SEARCH FOR PARENT MOLECULES AT MILLIMETER WAVELENGTHS IN COMETS P/GIACOBINI-ZINNER 1984E AND P/HALLEY 1982I
D. Bockelee-Morvan, J. Crovisier, D. Despois, T. Foreville, E. Gerard, J. Schrami, and C. Thum (Granada Univ., Spain) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 365-367 (For primary document see N87-25141 18-90)
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The rotational lines of potential parent molecules in comets P/Giacobini-Zinner 1984e and P/Halley 1982i were sought with a 30m radio telescope. The J = 1-O lines of HCN are unambiguously detected in P/Halley in November to December 1985 and February 1986. Upper limits are obtained for HCN in P/Giacobini-Zinner, and for HC3N, CH3CN, OCS and CO in P/Halley. The average HCN production rates for P/Halley are 0.72 times 10 to the 26th power/sec in Nov. to Dec. 1985, and 3.3 times 10 to the 27th power/sec in Feb. 1986. The line profiles suggest a gas expansion velocity of 0.8 km/sec in Nov. to Dec. (at rh = 1.5 AU) and 1.3 km/sec in Feb. (at rh = 0.6 AU). ESA

N87-25203*# California Univ., Berkeley. Dept. of Physics.
DETECTION OF OH FROM COMET HALLEY IN THE FAR-INFRARED
Gordon J. Stacey, John B. Lugten, and Reinhard Genzel (Max-Planck-Inst. fuer Physik und Astrophysik, Garching, West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 369-371 (For primary document see N87-25141 18-90)
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CSCL 03B

The 2 Pi 3/2 (J = 5/2 yields 3/2 + yields - parity) transition of OH was detected in comet Halley at 119.44 microns. The upper limit to the line intensity of the - yields + parity transition is 119.23 microns. The ratio of these lines is consistent with radiative pumping of the rotational levels through absorption of near ultraviolet solar photons which excite the low lying vibrational levels of OH. The far-infrared lines probe the inner regions of the coma where OH is produced through photodissociation of a parent molecule (presumably H2O). Hence, these lines complement the 18 cm radio measurements which are sensitive to the outer regions of the comet coma. The OH production rate is highly model dependent but is of the order 2 to 4 times 10 to the 29th power molecules/sec. ESA

N87-25204# Max-Planck-Inst. fuer Kernphysik, Heidelberg (West Germany).
CARBON STABLE ISOTOPES IN COMETS AFTER ENCOUNTERS WITH P/HALLEY
M. Solc, V. Vanysek (Karlova Univ., Prague, Czechoslovakia), and J. Kissel *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 373-376 (For primary document see N87-25141 18-90)
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The C 12/13 AMU signal ratio is discussed in terms of carbon isotopic abundances as a basis for cosmogonical conclusions. Selection of 38 PUMA 1 /mode 0/ mass spectra from Halley encounter with prominent 12 AMU peaks shows surprisingly variable 12/13 AMU signal ratio within 3 decades. If corrected for possible instrumental effects and contamination, the gross carbon isotopic data for P/Halley suggests C12 enrichment in volatile and refractory materials relative to the Solar System carbon isotopic ratio. ESA

N87-25205# Academy of Sciences (USSR), Dushanbe. Inst. of Astrophysics.
MULTICHARGED IONS IN HALLEY'S TYPE COMETS
S. Ibadov *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 377-378 (For primary document see N87-25141 18-90)
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Generation of multicharged ions due to high-velocity impacts of cometary and zodiacal dust particles is considered. Such processes also take place on the envelopes of spacecraft during their flight through interplanetary medium and especially intensively

during fly-by of Halley's type comets, i.e., comets rich in dusty matter and having retrograde orbital motion. In situ measurements could be carried out to give data on the ion component of comets. ESA

N87-25206*# Max-Planck-Inst. fuer Kernphysik, Heidelberg (West Germany).
EVIDENCE FOR HCS(+) AND CH2SH(+) IN THE INNER COMA OF COMET HALLEY
D. Krankowsky, P. Eberhardt, J. J. Berthelier, U. Dolder, R. R. Hodges, J. H. Hoffman, J. M. Illiano, P. Laemmerzahl, W. U. Schulte (Bern Univ., Switzerland), U. Stubbemann et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 381-382 (For primary document see N87-25141 18-90)
(Contract NASw-3576; Grants BMFT-01-OF-0516; BMFT-01-OF-0628; BMFT-01-OF-85-120; SNSF-2.034.0.81; SNSF-2.825-85; CNES-81,82/244; CNES-83/211; CNES-84,85/1211)
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Number densities for ion species with masses 44, 45, and 47 amu/q were derived from ram energy spectra of the neutral gas mass spectrometer experiment on Giotto in the inner coma of comet Halley. The relative abundances of the masses suggest the presence of the ions CS(+), HCS(+), and CH2SH(+). ESA

N87-25207*# Bern Univ. (Switzerland). Inst. fuer Physik.
ON THE CO AND N2 ABUNDANCE IN COMET HALLEY
P. Eberhardt, D. Krankowsky, W. Schulte, U. Dolder, P. Laemmerzahl, J. J. Berthelier, J. Woweries, U. Stubbemann, R. R. Hodges, J. H. Hoffmann (Centre de Recherches en Physique de l'Environnement, Saint Maur des Fosses, France) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 383-386 (For primary document see N87-25141 18-90)
(Contract NASw-3576; Grants SNSF-2.034.0.81; SNSF-2.825.85; BMFT-01-OF-0519; BMFT-01-OF-0628; BMFT-01-OF-85-120; CNES-81,82/244; CNES-83/211; CNES.84,85/1211)
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The mass 28 amu/e signal observed in the neutral mode of the Giotto neutral gas mass spectrometer (NMS) is evaluated. At 1000 km from the nucleus number density n(CO)/ n(H2O) is less than or = 0.07. The production rate of CO as a parent molecule directly from the nucleus is thus less than 7% of the H2O production rate. However, CO is also produced from an extended source in the inner coma (r is less than 20,000 km) and at 20,000 km from the nucleus, for the total equivalent CO production rate 0.05 is less than or = Q(CO)/Q(H2O) is less than or = 0.15. For N2 an upper limit Q(N2)/Q(H2O) is less than or = 0.1 is derived. No parent molecule for the CO is identified in agreement with the NMS measurements. It is proposed that CO or a very short-lived parent is released in the coma from cometary dust grains, such as the CHON particles. ESA

N87-25208# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
MEASUREMENTS OF NEUTRAL PARTICLE DENSITY IN THE VICINITY OF COMET HALLEY BY PLASMAG-1 ONBOARD VEGA-1 AND VEGA-2
A. P. Remizov, M. I. Verigin, K. I. Gringauz, I. Apathy, I. Szemerey, T. I. Gombosi, and A. K. Richter (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 387-390 (For primary document see N87-25141 18-90)
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In the PLASMAG-1 instrument package on board Vega-1 and Vega-2 a ram Faraday cup was used to measure the neutral gas density in the vicinity of comet Halley. The observational method and data measured on Vega-2 and on the outbound leg of Vega-1 are described. The density profiles of neutral particles in the coma of comet Halley out to cometocentric distances of 3 million km are presented. ESA

N87-25209*# Arizona Univ., Tucson. Dept. of Physics.
COMET HALLEY NEUTRAL GAS DENSITY PROFILE ALONG THE VEGA 1 TRAJECTORY MEASURED BY NGE
C. C. Curtis, C. Y. Fan, K. C. Hsieh, D. M. Hunten, Wing-H. Ip, E. Keppler, A. K. Richter, G. Umlauft, V. V. Afonin, A. V. Dyachkov (Academy of Sciences, USSR, Moscow) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 391-395 (For primary document see N87-25141 18-90)
(Contract NASw-3627; Grant NSF INT-82-05325)
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Data from the Vega 1 permitted the determination of the total neutral gas density profile along the spacecraft trajectory. Discounting small fluctuations, the field ionization source instrument measured a density profile which varied approximately as the inverse radial distance squared. Data from the electron impact ionization instrument yielded a series of calibration points; e.g., the neutral density at 100,000 km is 10,000/cc. The combined data provide a calibrated total density profile, and imply a neutral production rate of 10 to the 30th power molecules/sec. ESA

N87-25210# Tokyo Univ. (Japan). Geophysical Research Lab.
ULTRAVIOLET FEATURES OF COMET HALLEY OBSERVED BY SUISEI
E. Kaneda, M. Takagi, Kunio Hirao (Tokai Univ., Hiratsuka, Japan), M. Shimizu, and O. Ashihara *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 397-402 Original contains color illustrations (For primary document see N87-25141 18-90)
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Strong breathing of comet Halley with a period of 2.2 days was continuously observed throughout all phases in the apparition from Nov 14 1985 to April 14 1986. Postperihelion water production rates exceed preperihelion by a factor of 2 or 3. This suggests a postperihelion heating of the cometary nucleus. Fine structures in the Lyman alpha photometry data taken at the encounter indicate spatial variations of the atomic hydrogen density in the coma. These may correspond to shell structures in image data and be ascribed to the presence of a hydrogen source other than H2O in the cometary gas or dust particles. This second hydrogen source is expected to have a great value of photodissociation rate in comparison to that of H2O. ESA

N87-25211# Hulburt (E. O.) Center for Space Research, Washington, D.C.
H LYMAN-ALPHA IMAGERY OF COMET P/HALLEY FROM SOUNDING ROCKETS
R. P. McCoy, C. B. Opal (McDonald Observatory, Austin, Tex.), and G. R. Carruthers *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 403-407 (For primary document see N87-25141 18-90)
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Sounding rockets containing electrographic Schmidt cameras to image the hydrogen Lyman-alpna (121.5 nm) emission from comet Halley were launched on 24 Feb. 1986 and 13 Mar. 1986. The second rocket was launched 13 hr before the fly-by of the Giotto spacecraft. High quality images of the Lyman-alpha emissions from the comet were obtained on both flights. The images cover a 20 deg field of view with 3 arcmin resolution. The data from both flights were analyzed with a radial outflow model and hydrogen production rates of 1.86 times 10 to the 30th power/sec and 1.4 times 10 to the 30th power/sec obtained.

Analysis of the Lyman-alpha isophote displacements due to solar photon pressure yields a mean hydrogen outflow velocity of 8 km/sec. ESA

N87-25212# California Univ., Berkeley. Dept. of Astronomy.
VLA OBSERVATIONS OF COMET HALLEY: THE BRIGHTNESS DISTRIBUTION OF OH AROUND THE COMET
Imke dePater, Patrick Palmer, Lewis E. Snyder, and Wing-H. Ip (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 409-412 (For primary document see N87-25141 18-90)
(Grants NSF AST-85-14896; NATO-022/84)
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Very Large Array imaging of OH around Halley's comet is summarized. The emission seems concentrated in clumps, which surround a hole at the center. The hole is likely due to a quenching of the OH maser. ESA

N87-25213*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SPATIAL DISTRIBUTION OF (OI) 6300A EMISSION DETERMINED FROM NARROW-BAND IMAGES OF HALLEY'S COMET
F. L. Roesler, F. Scherb, K. Magee-Sauer, J. Harlander, R. J. Reynolds, R. J. Oliversen, R. V. Yelle, and A. L. Broadfoot (Arizona Univ., Tucson.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 413-415 (For primary document see N87-25141 18-90)
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In March 1986 the Wisconsin dual-etalon Fabry-Perot spectrometer was adapted for use with an intensified CCD imaging detector and good quality images of OI 6300A emission from a 10 arcmin field centered on Halley's comet head were obtained in April and May 1986. The 10 km/sec bandpass was adequate to eliminate spectral contamination from cometary NH2 and, with appropriate Doppler shifts, terrestrial airglow. The observed distribution of OI emission indicates O(sup 1)D production from 2 sources, presumably photodissociation of H2O and OH. Scale lengths are determined for the distributions of these sources in the coma. ESA

N87-25214*# Arizona Univ., Tucson. Dept. of Physics.
ANISOTROPY OF THE NEUTRAL GAS DISTRIBUTION OF COMET HALLEY DEDUCED FROM NGE/VEGA 1 MEASUREMENTS
K. C. Hsieh, C. C. Curtis, C. Y. Fan, D. M. Hunten, Wing-H. Ip, E. Keppler, A. K. Richter, G. Umlauft, V.V. Afonin, J. Eroe, Jr. (Central Research Inst. for Physics, Budapest, Hungary) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 417-421 (For primary document see N87-25141 18-90)
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The neutral gas density profile of comet Halley measured by the Neutral Gas Experiment on Vega 1 showed an asymmetry between the inbound and the outbound legs during the fly-by on 6 March 1986. The implications of this asymmetry are discussed, and it is shown how the asymmetry detected by NGE on Vega 1 can be traced back to regions on or near the nucleus to obtain their relative gas production activities at specific times of emission. ESA

N87-25215# McDonald Observatory, Austin, Tex.
FAR ULTRAVIOLET OBJECTIVE SPECTRA OF COMET P/HALLEY FROM SOUNDING ROCKETS
C. B. Opal, R. P. McCoy, and G. R. Carruthers (Hulburt, E. O. Center for Space Research, Washington, D.C) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas (dte) Dec. 1986 p 425-430 (For primary document see N87-25141 18-90)
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A sounding rocket payload to obtain far ultraviolet spectral images of comet P/Halley was launched on 1986 Feb 24 and again on 1986 Mar 13. The second flight occurred 13 hr prior to the Giotto spacecraft flyby of the comet. The payload included an objective grating spectrograph, consisting of an f/1.5 microchannel plate intensified electrographic Schmidt camera pointed at a plane grating. The instrument field of view was 12 deg with a spatial resolution of 1 arcmin and a point source wavelength resolution of 0.1 nm. High quality images of the oxygen coma at 130.4 nm, the carbon coma at 156.1 nm and 165.7 nm, and the sulfur coma at 181.4 nm were obtained. The images were analyzed using a radial outflow model to derive production rates for these species. ESA

N87-25216*# Johns Hopkins Univ., Baltimore, Md.
THE ATOMIC CARBON DISTRIBUTION IN THE COMA OF COMET HALLEY
T. N. Woods, P. D. Feldman, and K. F. Dymond *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 431-435 (For primary document see N87-25141 18-90)
(Grant NAG5-619)
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The radial distribution of CO, OI, Ci, and CII emissions in the coma of comet Halley were measured by a long-slit far ultraviolet spectrograph aboard a sounding rocket on 26 Feb. and 13 Mar. 1986. While the CO profiles strongly suggest that CO is vaporized directly from the nucleus, the observed carbon distribution is not consistent with a radial outflow model of CO, suggesting an additional source of atomic carbon in the inner coma. Based on the in situ plasma measurements from the Vega and Giotto spacecraft, it is possible that this additional source of carbon could be the recombination of ionized CO in the inner coma. ESA

N87-25217*# California Univ., Berkeley. Dept. of Astronomy.
OXYGEN PRODUCTION RATES FOR P/HALLEY OVER MUCH OF THE 1985-1986 APPARITION
Hyron Spinrad, Patrick J. McCarthy, and Michael A. Strauss *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 437-438 (For primary document see N87-25141 18-90)
(Grant NAGw-270)
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Long slit CCD spectrophotometry of comet P/Halley in the visible region was used to measure the production rate of atomic oxygen during the 1985/86 apparition. The observations cover a large range of heliocentric distances, since the technique is applicable to apparently bright and faint comets. The cometary gas production rate for P/Halley increases rapidly with decreasing heliocentric distance toward perihelion and is systematicaly larger at a given heliocentric distance for the postperihelion observations. The average production rate for O1D on the day of the Giotto flyby is 4 times 10 to the 28th power atoms/sec giving an extrapolated total water production rate of 6 times 10 to the 29th power mols/sec. A method for comparing the absolute cometary gas production rates for different comets is discussed. ESA

N87-25218*# Texas Univ., Austin. Dept. of Astronomy.
SPECTROPHOTOMETRIC OBSERVATIONS OF COMET HALLEY
A. L. Cochran and E. S. Barker *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 439-444 (For

primary document see N87-25141 18-90)
(Grants NGR-44-012-152; NSF AST-84-18196; NSF AST-83-14212)
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Comet Halley was observed using an intensified dissector scanner spectrograph on the 2.7 m telescope at McDonald Observatory from Dec. 1984 through June 1986. Molecular emissions were first detected in February 1985 when CN was observed. Spatial maps probing different regions of the coma were made starting in November 1985. Haser model production rates were computed for each night's data. The brightness of Halley, and therefore the production rates, are variable on timescales of a day, with variations of a magnitude or more in this time period. Nonequilibrium chemical models were calculated using Giotto and Vega data as constraints and inputs. The variability of Halley cannot be explained solely by water sublimation, nor do the variations show the 52 to 53 hr period of rotation. ESA

N87-25219# Vrije Universiteit, Brussels (Belgium). Inst. of Astrophyics.
PRE- AND POSTPERIHELION PHOTOMETRY OF COMET HALLEY FROM SEVERAL OBSERVATORIES
C. Sterken, J. Manfroid, and C. Arpigny (Liege Univ., Belgium) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 445-450 Sponsored by the Belgian National Fund for Scientific Research, Vrije Univ., and Liege Univ. (For primary document see N87-25141 18-90)
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Photoelectric observations of P/Halley were carried out during several weeks between 15 Sept. 1985 and 25 June 1986. All measurements were made using the standard IAU/IHW cometary filters. Large amplitude night-to-night changes over periods of several days superimposed on the general trend of slow brightness variation were seen. Smooth and irregular variations with a range up to 0.2 mag on time scales of several hours were observed. Present photometric scans of comet Halley through the various filters are presented. Successive integrations were made every 5 arc sec, radially from the center out to a distance of 5 arcmin, essentially along the sunward-antisunward direction and in the direction perpendicular to it. ESA

N87-25220# Observatoire de Besancon (France).
SPECTROSCOPIC OBSERVATIONS OF COMET HALLEY AT WAVELENGTHS 275 TO 710 NM FROM VEGA 2
G. Moreels, J. Clairemidi, J. P. Parisot, J. M. Zucconi, J. L. Bertaux, J. E. Blamont, M. Herse, V. A. Krasnopolsky, V. I. Moroz, A. A. Krysko (Academy of Sciences, USSR, Moscow) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 451-456 Sponsored by CNES (For primary document see N87-25141 18-90)
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During the Vega 2 observation sessions, 3600 spectra of comet Halley in the range 275 to 710 nm were obtained with the NUVI channel of the TKS instrument. A scanning system allowed to explore a field of view of 2 deg x 1.5 deg. The spectra obtained at the end of the encounter session show that, when the impact parameter is minimum, p = 120 km, gaseous emissions are still present superposed on an intense continuum. The intensities of the OH, CN, C3, and C2 emissions and dust continuum show different evolutions when the impact parameter decreases from 5000 to 120 km. The emissions of OH at 309 nm and CN in the band head at 388 nm are relatively flat; C2 and C3 increase during the approach. Monochromatic charts obtained on Mar 10 1986 are presented for the OH, CN, and C2 emissions. The spectral characteristics of dust albedo when p decreases are pointed out. The OH intensity curve as a function of p is presented. ESA

N87-25221# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
NEAR INFRARED SPECTROSCOPY OF COMET HALLEY BY THE VEGA-2 THREE CHANNEL SPECTROMETER
V. A. Krasnopolsky, V. I. Moroz, A. A. Krysko, V. S. Jegulev, A. Yu. Tkachuk, M. Gogoshev, Ts. Gogosheva, G. Moreels, J. Clairemidi, and J. P. Parisot (Observatoire de Besancon, France) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 459-463 (For primary document see N87-25141 18-90)
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Continuum radiation produced by cometary dust scattering, the water vapor band at 1.38 microns, OH rovibrational bands, and the CN (0,0) band at 1.1 microns are discussed. Dust production rate equals 14 tonne/sec with angular distribution proportional to cos phi superposed by ejection in a cone of 25 deg. Dust material density p = 0.63 a mum g/cc where a mum is the particle radius in microns. Dust scattering spectrum in the range of 0.25 to 2 microns is discussed. Intensities of the H2O band at 1.38 microns are 0.2 MR and 1.3 MR at phase angle 90 and 35 deg respectively. Its angular distribution is narrower than that of dust with more pronounced jets. Velocities of gas and dust equal 0.85 + or - 0.15 km/sec and sq rt 0.54 (p a mum) km/sec respectively. Spatial distribution of CN bands demonstrates existence of a second parent with scale length of 600 km at 1 AU and production rate 20% of that of HCN. ESA

N87-25222# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
CURVES OF GROWTH OF EMISSION LINES IN COMETARY SPECTRA: IMPLICATIONS TO H2O AND OH BANDS OF COMET HALLEY
V. A. Krasnopolsky and A. Yu. Tkachuk *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 465-469 (For primary document see N87-25141 18-90)
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Curves of growth of emission lines are calculated for parent and secondary species with Haser model of comets. Variations of these curves when varying input parameters are discussed. The technique developed is applied to the measurements of H2O 2.7 and 1.38 micron bands by the Vega spacecraft and to OH 3090A band measured by Vega 2 and IUE. Evaluation of the H2O total production rate of 10 to the 30th power/sec on Mar. 9, 1986 obtained by this technique should be considered as the lower limit and the real value may be a factor of 1.5 to 2 over due to H2O ejection in sunward direction. ESA

N87-25223# Liege Univ. (Belgium). Inst. d'Astrophysique.
LONG-SLIT PRE AND POSTPERIHELION SPECTROGRAPHY OF COMET P/HALLEY
C. Arpigny, F. Dossin, J. M. Zucconi, Y. Andrillat (Universite des Sciences et Techniques du Languedoc, Montpellier, France), J. Manfroid, and D. Hutsemekers *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 471-474 (For primary document see N87-25141 18-90)
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A series of 40 long-slit spectra of Halley's comet was secured in the optical wavelength region using different instruments at resolution ranging from 0.05 to 1.6 nm. The interval of heliocentric distance r covered by the observations is 1.7 to 0.9 AU before perihelion, while r = 0.95 AU after perihelion. The main characteristics of the preperihelion spectra are described. Emissions due to the OH(+) (0,1) and CH(+) (1,0) bands are detected. ESA

N87-25224# Indian Inst. of Astrophysics, Bangalore.
SPATIAL DISTRIBUTION OF MOLECULES AND DUST WITHIN THE COMA OF COMET HALLEY

K. R. Sivaraman, G. S. D. Babu, B. S. Shylaja, and R. Rajamohan *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 479-480 Sponsored in part by the Indian Dept. of Space (For primary document see N87-25141 18-90)
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Spectral scans of comet Halley were made at high spatial resolution using the Cassegrain focus (f/13) of the 102 cm reflector at Kavalur (India). The scans cover the wavelength region from 3900 to 6200 A and at 40 A resolution and on a few occasions in the blue region at 20 A resolution. The f/13 beam provided an image of the coma with a scale of 15.5 arc sec/mm. Scans were obtained on several consecutive nights in Mar. 1986 with a 25.9 arcsec entrance aperture of the scanner at discrete and systematically displaced locations within the coma, in the direction of the tail as well as normal to it about the position of the nucleus. The spatial gradients of the distribution of the molecular species and dust were derived from the brightness profiles. ESA

N87-25225*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GASEOUS JETS IN COMET P/HALLEY
Michael F. AHearn, Susan Hoban, Peter V. Birch, Craig Bowers, Ralph Martin (Perth Observatory, Australia), and Daniel A. Klinglesmith, III *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 483-486 (For primary document see N87-25141 18-90)
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CSCL 03B

Properties of the gas jets in P/Halley reported to exist in images taken in the light of CN are described. The jets also exist in the light of other radicals, specifically C2. The jets do not exist in the continuum images although it appears that one of the jets seen may come from the same area on the nucleus that produces much of the dust. The jets are seen to persist, although with varying geometry, for 2 months or more, from the time of the spacecraft encounters in March to the beginning of May. The strength of the jets is well correlated with fluctuations in the overall production rate of radicals by the comet. ESA

N87-25226*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CN JETS OF COMET P/HALLEY: ROTATIONAL PROPERTIES
Nalin H. Samarasinha, Michael F. AHearn, Susan Hoban (Maryland Univ., College Park.), and Daniel A. Klinglesmith, III *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 487-491 (For primary document see N87-25141 18-90)
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An analysis of CCD images of CN jets of comet P/Halley observed during April 16 to 29 1986 is discussed. The analysis questions the 53 hr rotation period and favors a rotational period of 7.37 days, as suggested by Millis and Schleicher (1986). It is shown that a change in rotation period, at least from one apparition to the next, is also possible. A lower limit for the ejection velocity of dust grains (which emit CN) in the jet is established to be 0.5 km/sec with an uncertainty of 50%. The constraints on the direction of the rotation axis as inferred from the geometry of the jets are considered. ESA

N87-25227# University Coll., London (England). Dept. of Physics and Astronomy.
OPTICAL OBSERVATIONS OF THE NEUTRAL AND ION COMA OF COMET HALLEY
David Rees, Nigel P. Meredith, and Max K. Wallis (University Coll., Cardiff, Wales) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 493-498 Sponsored by UK Science and Engineering Research Council (For primary document see N87-25141 18-90)
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Narrow-band spectral images of constituents of the neutral coma (CN, C2, CH, O, H, NA), and of the ion coma and tail formation of comet P/Halley were obtained during 4 observing periods between late Nov. 1985 and mid-June 1986. The CN coma was detectable to a distance of > 4 M Km in Dec. 1985, and 5 to 6 M km in early March 1986. The inner (assumed parent) and outer (assumed daughter) Haser scale lengths of the CN coma are found to each have a dependence on (R) sq. A narrow, tail-like, feature in CN emission, occasionally extending 10 M km antisunward, may be due to sputtering of dust grains present within the ion tail core. ESA

N87-25228*# Arizona State Univ., Tempe. Dept. of Physics.
SPECTRA OF THE PLASMA TAIL OF COMET P/GIACOBINI-ZINNER AT THE TIME OF THE ICE COUNTER
S. Wyckoff, P. A. Wehinger, I. Konno, Hyron Spinrad, and M. J. S. Belton (Kitt Peak National Observatory, Tucson, Ariz.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 499-501 (For primary document see N87-25141 18-90)
(Grant NAGw-547)
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CSCL 03B

Ground-based CCD spectra of comet P/Giacobini-Zinner were obtained at the time of the ICE encounter. A spectral extraction gives the spectrum of the comet at the position and time of the spacecraft at midencounter. Column densities are given for neutral and ion molecules observed. The surface brightness profile for H2O(+) from 1000 km sunward to 34,600 km tailward obtained at the time of the encounter is also presented. ESA

N87-25229*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ION MORPHOLOGY IN THE INNER TAIL OF COMET P/HALLEY
Susan Hoban, Michael F. AHearn, Peter V. Birch, Michael P. Candy, Ralph Martin (Perth Observatory, Australia), and Daniel A. Klinglesmith, III *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 505-506 (For primary document see N87-25141 18-90)
(Grants NsG-7322; NST INT-85-14707)
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Comet Halley CCD images taken in the light of CO(+) and H2O(+) were analyzed. Most of the ionic emission originates in a diffuse component on which the ion ray structure appears to be superimposed. On average, the peak enhancement in the CO(+) rays is 20% over the adjacent minima, where the emission is due to the underlying component. The H2O(+):CO(+) ratio varies by as much as 30% from ray to ray. ESA

N87-25230# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).
A COMPARISON OF GROUND-BASED CCD H2O(+) OBSERVATIONS WITH THE GIOTTO MEASUREMENTS AT COMET HALLEY
Wing-H. Ip, C. B. Cosmovici, and P. Mack (South African Astronomical Observatory, Cape Province.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 507-510 Original contains color illustrations (For primary document see N87-25141 18-90)
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An analysis of the CCD imaging observations with H2O(+) ion filters taken just hours after the Giotto flyby at comet Halley indicate

that secondary peaks in the H2O(+) ion density might exist upstream and on the flank sides of the comet. Such structures of plasma origin could be related to the plasma pile-up region as detected by the ion mass spectrometer and neutral mass spectrometer experiments on Giotto. Fast time variability for such plasma structures may also exist. ESA

N87-25231*# Observatoire de Paris-Meudon (France). Dept. de Recherche Spatiale.
COMET P/GIACOBINI-ZINNER ELECTRON AND H2O COLUMN DENSITIES FROM ICE AND GROUND-BASED OBSERVATIONS
N. Meyer-Vernet, Michael A. Strauss, J. L. Steinberg, Hyron Spinrad, and Patrick J. McCarthy (California Univ., Berkeley.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 511-514 Previously announced in IAA as A87-31354 Sponsored in cooperation by a Berkeley Univ. Graduaduate Fellowship (For primary document see N87-25141 18-90)
(Grant NAGw-270)
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An H2O(+) emission profile extracted from an optical CCD spectrogram obtained during the ICE/Giacobini-Zinner encounter is compared to the electron density profile deduced from in-situ measurements by the ratio experiment aboard ICE. It is concluded that the electrons and the H2O(+) ions are distributed similarly 9600 km tailward from the cometary nucleus; that the ratio of number densities of H2O(+) ions to electrons is 1/4 at this point; and that the width of the plasma sheet is 16,000 km. ESA

N87-25232# Observatoire de Paris-Meudon (France). Dept. d'Astrophysique Fondamentale.
ELECTRONIC SPECTROSCOPY AND RELAXATION OF MOLECULAR CATIONS OF COMETARY INTEREST
Sydney Leach *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 515-521 (For primary document see N87-25141 18-90)
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Laboratory studies of the electronic spectra and nonradiative relaxation properties of singly-charged molecular cations are discussed. Their interest for cometary physics is emphasized. Spectroscopic information is given on CS(+), SH(+), CO2(+), CS2(+) and H2S(+). Coincidence techniques were used for studying radiationless transitions in CO2(+) NH3(+) and other polyatomic ions. The results were amplified by laser excitation methods in the case of CO2(+). The fluorescence quantum yields are measured for molecular ions which could be formed from parent molecules likely to exist as frozen gases in comet nuclei. The possibility of spectral observation of these cations in comets is considered. ESA

N87-25233# Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau (West Germany).
ANISOTROPIC NONSTATIONARY GAS FLOW DYNAMICS IN THE COMA OF COMET HALLEY
N. I. Koemle and Wing-H. Ip (Oesterreichische Akademie der Wissenschaften, Vienna.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 523-527 (For primary document see N87-25141 18-90)
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Numerical model calculations which address outflow patterns that may occur at comet Halley are discussed: steady state outflow dominated by a strong gas source at the subsolar point, and steady state gas flow caused by a ring-like outgassing region. In both cases the anisotropies introduced at the comet's surface are maintained out to large distances, i.e., several thousand kilometers. The transient stages of the gas flow immediately after onset or offset of the strong outgassing at the subsolar point are considered. ESA

N87-25234*# Los Alamos Scientific Lab., N. Mex.
MODEL ION ABUNDANCES FOR COMET HALLEY
W. F. Huebner, D. C. Boice, J. J. Keady, H. U. Schmidt, and R. Wegman (Max-Planck-Inst. fuer Astrophysik, Garching, West Germany) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 529-531 Previously announced as N87-21783 Sponsored by NASA Planetary Atmospheres Program (For primary document see N87-25141 18-90)
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CSCL 03B

A computer model for comet comae was applied to predict ion abundances for comet Halley, assuming that the volatile component of the nucleus is 85% water and that the remaining volatile molecules are composed of carbon, nitrogen, oxygen, and sulfur. Model parameters such as heliocentric distance, size, and albedo are chosen to be consistent with the 13 to 14 March 1986 encounter of Giotto with the comet. Photoprocesses, gas-phase chemical kinetics, coma energy balance including a separate electron temperature, multifluid hydrodynamics with a transition to free molecular flow, fast streaming atomic and molecular hydrogen, and counter and cross streaming of species in the coma-solar wind interaction are taken into consideration. A comparison of the model results with data from the ion mass spectrometer at 6000 and 1500 km from the nucleus shows good agreement. Implications of the coma physics and chemistry are discussed. ESA

N87-25235# Centre National de la Recherche Scientifique, Verrieres-Le Buisson (France). Lab. de Physique Stellaire et Planetaire.
IMPROVEMENTS IN HYDRODYNAMIC MODELS OF COMET HALLEY DUSTY ATMOSPHERE: INITIAL BOUNDARY CONDITIONS AND HOMOGENEOUS NUCLEATION
J. F. Crifo *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 533-538 (For primary document see N87-25141 18-90)
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Two effects associated with the solid-gas phase transition assumed to control cometary activity, i.e., nucleus ice sublimation and homogeneous recondensation in the fluid expansion region are reconsidered using gasdynamic methods. Physically consistent expressions are proposed for the assessment of the initial boundary conditions of the fluid expansion region. The classical homogeneous nucleation theory is applied, taking into account the presence of dust. It is found that water vapor expands in an initially supersaturated state, contrary to previous assumption. However, due to the convective exchanges between gas and grains, the nucleation rate is much smaller than in the case of pure adiabatic expansion. ESA

N87-25236*# Bern Univ. (Switzerland). Inst. fuer Physik.
THE D/H RATIO IN WATER FROM HALLEY
P. Eberhardt, U. Dolder, W. Schulte, D. Krankowsky, P. Laemmerzahl, J. H. Hoffman, R. R. Hodges, J. J. Berthelier, and J. M. Illiano (Centre de Recherches en Physique de l'Environnement, Saint Maur des Fosses, France) *In* ESA Proceedings of the 20th ESALB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 539-541 (For primary document see N87-25141 18-90)
(Contract NASw-3576; Grant SNSF-2.034-0.81)
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CSCL 03B

The neutral gas mass spectrometer on Giotto made neutral and ion composition measurements with a high mass resolution. Evaluation of the ion data within the contact surface gives a D/H

ratio in water from Halley between 0.00006 and 0.00048. While this ratio is definitely not compatible with the D/H in molecular hydrogen of the protosolar nebula or the Jovian and Saturnian atmospheres, it is in the range observed for hydrogen in solar system objects which acquired their hydrogen as part of volatile molecules, e.g., as ices. ESA

N87-25237*# California Univ., Davis. Dept. of Chemistry.
A COMPARISON OF THE HIGH RESOLUTION IUE OBSERVATIONS OF CS EMISSION IN COMETS HALLEY AND GIACOBINI-ZINNER
William M. Jackson (California Univ., Berkeley.) and M. G. Prisant *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 545-551 (For primary document see N87-25141 18-90)
(Grants NAGw-466; NAGw-903)
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CSCL 03B

The high resolution spectra of comets Giacobini-Zinner and Halley were measured in the region of the CS emission. Both spectra have essentially the same shape, but the Halley spectrum has a better signal to noise ratio. The rotational distribution of the radical in these comets was derived by using an inversion program and spectral simulation. Both procedures suggest that the rotational distribution is dominated by CS radical with J' is less than or = 5. Despite this it appears that another distribution with higher J' is needed to explain the shape of the rotational distribution. It is suggested that this second distribution is due to a balance between collisions and radiation in the inner coma. ESA

N87-25238# Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
OBSERVATIONS OF COMET P/HALLEY AT MINIMUM PHASE ANGLE
K. J. Meech and D. C. Jewitt *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 553-556 (For primary document see N87-25141 18-90)
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Time-series spectra of comet P/Halley obtained over 8 nights in Nov 1985 in near backscattering geometry (phase angle 1 to 10 deg.) were used to search for enhanced backscattering of the type reported in comet P/Stephan-Oterma and to study the time dependence of the molecular band and continuum emissions. No phase related brightening at minimum phase greater than 10% is observed in P/Halley, however 2 continuum brightness outbursts were obseved on UT Nov. 15 and 21. The first of these was associated with a comparable increase in the gas band emission strength, the second was not. The absence of a gas emission increase in the second outburst is evidence for the possible existence of a dust crust on the nucleus. No time delayed brightening is seen at a coma position 40 arcsec west of the nucleus suggesting that either the grains are ejected a velocities below the escape velocity or that they are short-lived icy grains. ESA

N87-25239# Catania Astrophysical Observatory (Italy). Ist. di Astronomia.
PHOTOMETRY OF P/HALLEY (1982I) AT CATANIA (ITALY) OBSERVATORY
F. A. Catalano, G. A. Baratta, C. LoPresti, and G. Strazzulla *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 557-560 (For primary document see N87-25141 18-90)
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Photoelectric photometry of Halley's comet was carried out at a 91 cm telescope using the C2, C3, Cn, BC, and UC IHW standard filters. To compute the gas production rates of the C2, C3, and CN molecules, the Haser model was used. The production rates of solids, that are supposed to scatter the continuum radiation, were also computed. Results show that the preperihelion and postperihelion production rates, both for gas and dust, have a different behavior with solar distance. It is not possible to reconcile the results as a whole with an H2O ice dominated sublimation. They seem however to be not incompatible with a nucleus of polymer-like composition. ESA

N87-25240*# Rice Univ., Houston, Tex.
HIGH PRECISION LOW RESOLUTION SPECTROPHOTOMETRY OF COMETS GIACOBINI-ZINNER AND HALLEY
C. R. ODell and Stephen C. Tegler *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 561-563 (For primary document see N87-25141 18-90)
(Grants NAG8-485; NSF AST-85-05031)
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CSCL 03B

Optical window (300 to 1000 nm) observations were made of Comet Halley during 12 to 14 Mar. 1986 by a scanning spectrometer. The results provide accurate spectrophotometric measurements of the principal molecular bands from the 308 nm OH through the 918 nm CN emissions. The observations can be used to tie space derived ultraviolet and groundbased infrared observations to the optical observations and to one another. Additional observations were made of comet Giacobini-Zinner on 30 September 1985 of the same OH band and the 388 nm band of CN. The Swan band sequence ratios are used to test the best models of C2, with different ratios favoring different models, calling into question the assumptions of these very complete models. ESA

N87-25241*# Lowell Observatory, Flagstaff, Ariz.
THE VARIABILITY OF HALLEY'S COMET DURING THE VEGA, PLANET-A, AND GIOTTO ENCOUNTERS
D. G. Schleicher, R. L. Millis, D. Tholen, N. Lark, Peter V. Birch, Ralph Martin, and Michael F. AHearn (Maryland Univ., College Park.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 565-567 Sponsored in part by NASA (For primary document see N87-25141 18-90)
(Grant NSF AST-78-27879)
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Narrowband photometry of Halley obtained at Cerro Tololo Inter-American Observatory (CTIO), Mauna Kea Observatory (MKO), and Perth Observatory was combined to determine the relative level of activity during the interval spanning the spacecraft encounters. Measurements of the flux from the comet in emission bands of OH, NH, CN, C3, and C2, as well as at 2 continuum points, were obtained at CTIO on each night between 5 March and 17 March 1986. Observations were made on many of these same dates at MKO and Perth using comparable interference filters. The date clearly show variation of a factor of 2.5 in the production of all observed species with a characteristic time scale of a few days. ESA

N87-25242# Observatoire du Pic-du-Midi, Bagneres de Bigorre (France).
POLARIMETRY OF MOLECULAR BANDS IN COMETS P/HALLEY AND HARTLEY-GOOD
J. F. LeBorgne, J. L. Leroy, and J. Arnaud *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 571-576 (For primary document see N87-25141 18-90)
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Measurements of the linear polarization of molecular bands in comets P/Halley and Hartley-Good are presented. The measured bands are the C2 Swan band at 5140A, the CN 3880A band, the C3 4060A band, and the OH 3090A band. The phase angle dependance of the polarization of C2, C3, and CN is in good agreement with theory. However the polarization of OH is five

times smaller than foreseen. The direction of polarization of C2, C3, and OH is usually perpendicular to the scattering plane, though some measurements are parallel to it. For CN half the measures shows significant deviations from the perpendicular to the scattering plane. ESA

N87-25243*# Five-College Astronomy Dept., Amherst, Mass.
HCN PRODUCTION FROM COMET HALLEY
F. Peter Schloerb, Wayne M. Kinzel, Daryl A. Swade, and William M. Irvine *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 577-581 Sponsored in cooperation with the Commonwealth of Massachusetts, and the NSF US-France Cooperative Science Program (For primary document see N87-25141 18-90)
(Grants NGL-22-010-023; NSF AST-85-12903)
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CSCL 03B

Observations of the HCN J=1-0 rotational transition at 3.4 mm wavelength in comet P/Halley with a 14m antenna were obtained during 56 individual observing sessions between Nov. 1985 and May 1986. The HCN production rate is well correlated with the total visual magnitude of the comet, indicating that HCN follows the overall gas and dust production. However, comparison of HCN production to the total gas production of the comet indicates that it is a relatively minor consituent with 0.1% of the abundance of H2O. Spectra obtained by binning the HCN data with heliocentric distance show that the HCN line width, and thus the parent outflow velocity, increases with decreasing heliocentric distance, and that there is a tendency for the lines to be blue shifted as expected from the observed anisotropic outgassing from the nucleus. There is evidence of day-to-day time variability in the total HCN emission and variations in the HCN hyperfine ratios from their LTE values. ESA

N87-25244*# Five-College Astronomy Dept., Amherst, Mass.
OH RADIO OBSERVATIONS OF COMET HALLEY
F. Peter Schloerb, Mark J. Claussen, and Lowell Tacconi-Garman *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 583-587 Sponsored in cooperation with the NSF US-France Cooperative Science Program (For primary document see N87-25141 18-90)
(Grant NGL-22-010-023)
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CSCL 03B

Results of OH observations of P/Halley obtained with the NRAO 43 m antenna between July 1985 and May 1986 are presented. Using Radio Model 1986a, the OH production rate derived from these data follows an rh(-2) law for heliocentric distances in the range 0.6 to 2.1 AU. Comparison of radio OH production rates to those estimated by UV techniques continues to show that the radio technique finds systematically lower production rates. Observations of the OH line shape show that the line width increases as the comet approaches perihelion, and that the broader line widths persist after perihelion out to at least rh = 1AU. Modeling of the profiles suggest that this may be accounted for through an increase in the velocity of the OH parent. The mean velocity of the OH emission (after correction for the OH Greenstein effect) is slightly blue shifted compared to the nucleus velocity and suggests that the outgassing from the nucleus is largely directed sunward. ESA

N87-25245# Observatoire de Paris-Meudon (France).
THE 18 CM WAVELENGTH RADIO MONITORING OF THE OH RADICAL IN COMET P/HALLEY 1982I
E. Gerard, D. Bockelee-Morvan, G. Bourgois, P. Colom, and J. Crovisier *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 589-594 (For primary document see N87-25141 18-90)
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The 1667 and 1665 MHz transitions of the OH radical were detected and monitored nearly daily in comet Halley 1982i with the Nancay radio telescope. The observations cover the period July 1985 to July 1986 and provide a test for the excitation mechanisms of the OH molecule and the kinematic models of the OH coma. The heliocentric velocity range was fully observed between -26.8 and 26.8 km/sec. and 6 line reversals were observed. The OH parent production rate of P/Halley was measured between 3.4 and 0.6 AU from the Sun. Significant short-term variations of the OH parent production rate in a few days, large variations of the half power profile width, and anomalous line shapes are found. ESA

N87-25246# Instituto Argentino de Radioastronomia, Buenos Aires (Argentina).
POST-PERIHELION RADIO MONITORING OF THE OH IN COMET HALLEY
I. F. Mirabel (Puerto Rico Univ., Rio Piedras.), E. Bajaja, E. M. Arnal, J. C. Cersosimo, F. R. Colomb, M. C. Martin, J. Mazzaro, R. Morras, W. G. L. Poppel, A. M. Silva et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 595-598 (For primary document see N87-25141 18-90)
(Grant NSF INT-85-14854)
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Post-perihelion observations of the 1667 MHz OH line in comet Halley are reported. Using a 30-m antenna in Argentina, P/Halley was detected from March 22 to April 30 1986. Strong absorption by the OH in the coma was observed during occultation of galactic background radio sources. The daily monitoring reveals outbursts with variations in the content of gas of up to a factor of 2.7 in 24 to 48 hr. Three OH bursts lasting six days each were observed. The observations are consistent with discrete and anisotropic release of gas toward the coma, and with the estimated lifetimes of the H2O and OH. ESA

N87-25247# Kitt Peak National Observatory, Tucson, Ariz.
A PRECISE SPIN PERIOD FOR P/HALLEY
M. J. S. Belton, P. Wehinger, S. Wyckoff, and Hyron Spinrad (California Univ., Berkeley.) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 599-603 (For primary document see N87-25141 18-90)
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Observed fluctuations in the brightness of P/Halley when it was further than 5 AU from the Sun were studied for evidence of nuclear rotation. Only data of the highest photometric quality is used and the search for periodicity is limited to the range of periods allowed by Vega and Giotto images. The search algorithm is based on a three component harnonic model which improves the physical interpretation of the results and filters out many spurious responses to noise and possible aperiodic variability in the data. Two acceptable periods are found: 53 h 58 m +/- 2 m; and 54 h 07 m +/- 2 m. ESA

N87-25248# Wise Observatory, Tel Aviv (Israel).
PERIODIC LIGHT VARIATIONS IN THE NEAR NUCLEUS ZONE OF COMETS P/HALLEY AND P/GIACOBINI-ZINNER
E. M. Leibowitz and N. Brosch *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 605-607 (For primary document see N87-25141 18-90)
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Photoelectric photometric measurements in the near nucleus zone of comets P/Halley and P/Giacobini-Zinner were performed. Results reveal periodic light variations in the 2 objects, with periods of 52 h and 9.5 h respectively. The variations observed in P/Halley are detected mainly in the radiation in emission lines. They are

interpreted as resulting from a periodic modulation of the ejection of the line emitting molecules from the nucleus into the near zone, due to the rotation of the nucleus. A production duration of 30 hr is derived for the daughter molecule C2 at the time of the observations. In the P/Giacobini-Zinner case, the variations are found mostly in the contiuum radiation and they are interpreted as the reflection of sunlight from the rotating solid nucleus of the comet. ESA

N87-25249*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
OBSERVATIONAL FACTORS AFFECTING STUDIES OF COMET P/HALLEY'S VISUAL LIGHT CURVE
Stephen J. Edberg and Charles S. Morris *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 609-612 (For primary document see N87-25141 18-90)
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Over 5000 visual magnitude estimates of comet Halley were used as a data base for studying the factors which affect the distribution of visually estimated total magnitudes of comets. Observations made on eight selected days were studied. It is concluded that scatter in the magnitude data is a function of (in order of importance) observer experience, comet morphology, and instrumentation used. Experienced observers generally report the brightest magnitude estimates. ESA

N87-25250*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE VISUAL BRIGHTNESS BEHAVIOR OF P/HALLEY DURING 1981-1986
Daniel W. E. Green (Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass.) and Charles S. Morris *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 613-618 (For primary document see N87-25141 18-90)
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The behavior of the total visual coma brightness of P/Halley during 1981 to 1986 is discussed. Observations used include 75 published V magnitudes obtained with large telescopes (usually with CCDs) prior to July 1985 and 650 total magnitudes estimated visually with smaller telescopes during the period July 1985 to Aug 1986. The macroscopic light curve is discussed, and least-square fits to the traditional power-law formula are provided. Further work is needed to apply physically-meaningful formulae, based on models describing dust and gas-production rates, to the observed light curve of P/Halley. Brightness variations on smaller timescales (hours, days) are reviewed. ESA

N87-25251 Cornell Univ., Ithaca, N.Y.
ARECIBO EMISSION-ABSORPTION STUDIES OF THE INTERSTELLAR MEDIUM Ph.D. Thesis
Sean W. J. Colgan 1986 224 p
Avail: Univ. Microfilms Order No. DA8628424

Arecibo emission-absorption studies of HI, high velocity HI, OH, and H2CO are presented. Errors in galactic HI spectra caused by stray radiation into the far sidelobes of the antenna power pattern are estimated from calibration measurements and observations toward the Moon. From observations toward nineteen low galactic latitude continuum sources, the variation of HI properties with latitude are explored. The observation of column density and integrated optical depth are consistent with high latitude studies when allowance is made for the well known deficiency of HI in the solar neighborhood. A survey for emission and absorption from high velocity HI shows that there is little cold, high velocity HI. The OH observations towards the nineteen low latitude continuum sources have resulted in the detection of 11 absorption features. A comparison of the OH velocities and linewidths HI and CO studies indicates that the OH is confined to small volumes within the CO and HI regions. The H2CO absorption toward 3C 154 anc 3C 123 was studied. Toward 3C 123 the H2CO line has a dispersion of only 0.13 km/s. The abundance of H2CO relative to OH and CH varies by at least a factor of five between two otherwise similar regions. A VLA map shows that the absorption across 3C 123 is constant to 10%. Dissert. Abstr.

N87-25252 Harvard Univ., Cambridge, Mass.
NUCLEAR REACTIONS AT HIGH DENSITIES AND THERMONUCLEAR SHELL FLASHES ON ACCRETING NEUTRON STARS AND X-RAY AND GAMMA-RAY BURSTS Ph.D. Thesis
Ikko Fushiki 1986 217 p
Avail: Univ. Microfilms Order No. DA8704404

Nuclear reactions at high density and low temperature were studied. The strong interaction penetration factor was related to the weak interaction Fermi factor. An expression was derived for the penetration factor that, unlike the usual expression, is independent of the nuclear potential. Using this expression, analytical expressions were derived for the nuclear reaction rate in the strong screening and pycnonuclear regimes. The penetration factor is usually calculated using the WKB approximation with a boundary condition appropriate to one dimension. It should be pointed out that a proper treatment requires a boundary condition appropriate to three dimensions, and this can significantly alter the reaction rate. The nuclear reaction rates were applied to nuclear burning models of X-ray and Gamma-ray bursts. The notions of nuclear burning shell and ignition point were precisely defined, and detailed numerical calculations of the envelope structure of accreting neutron stars were used to determine them. The global stability of this structure was studied, and the different burst behavior was related to different stages in accretion rate.
Dissert. Abstr.

N87-25253 Harvard Univ., Cambridge, Mass.
THE PROPERTIES OF SUPERCLUSTERS Ph.D. Thesis
J. Marc Postman 1986 138 p
Avail: Univ. Microfilms Order No. DA8704441

Over the past decade and a half the study of the formation and evolution of galaxies, clusters, and superclusters has experienced remarkable growth. Advances in detectors and digital image processing have made the acquisition of galaxy redshifts and photometry much simpler and less time-intensive. In an attempt to answer questions regarding the nature of superclusters a global statistical analysis of the Abell and Zwicky cluster catalogs was performed. The distribution and dynamics of galaxies in the region of the Corona Borealis supercluster were studied in finer detail. The magnitude-redshift relation for Abell clusters and the reliability of redshift estimates based on photometric data are discussed. The large scale distribution of galaxies in the Corona Borealis is described. The dynamics and kinematics of the galaxies in the Corona Borealis are also described. Dissert. Abstr.

N87-25254 Pennsylvania State Univ., University Park.
ROTATION AND ACTIVITY IN X-RAY SELECTED LATE TYPE STARS Ph.D. Thesis
Leo Olavi Takalo 1986 189 p
Avail: Univ. Microfilms Order No. DA8705421

A spectroscopic study of 9 X-ray selected late type stars was conducted. These stars are X-ray bright, serendipitously discovered EINSTEIN X-ray sources. The stars were selected from two large X-ray surveys; the Columbia Astrophysical Laboratory X-ray survey (5 stars) and the CFA Medium Sensitivity survey (MSS, 4 stars). Spectral classes for the stars were determined and radial and rotational velocities were measured. Four of the Columbia survey stars are found to be short period binary systems. The fifth Columbia survey star is found to be an active single G dwarf. Activity in the stars is studied by comparing the Balmer lines and the Ca II infrared triplet (IRT) lines to the lines in inactive stars, and measuring the excess emission in these lines. All the Columbia survey stars are found to show excess emission in these lines. Also in all these stars this excess showed variabiliiy. The MSS survey stars do not show any excess in these lines. A correlation

is found to exist between the luminosity of the excess medium in the lines and rotational excess in these lines. Dissert. Abstr.

N87-25035# University Coll., London (England). Dept. of Physics and Astronomy.
THE BIRTH OF STARS
D. McNally *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 51-55 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25041# Tata Inst. of Fundamental Research, Bombay (India).
THE LIGHTER SIDE OF GRAVITY
J. V. Narlikar *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 81-85 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25044# Tromsoe Univ. (Norway). Inst. of Mathematical and Physical Sciences.
THE CONNECTION BETWEEN THE EARTH AND THE UNIVERSE - MADE VISIBLE BY THE NORTHERN LIGHT
Jan-Erik Solheim *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 103-111 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25047# Copenhagen Univ. (Denmark). Astronomy Observatory.
COSMOLOGY
Kjeld Gyldenkerne *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 129-136 (For primary document see N87-25026 18-89)
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N87-25058# Technical Univ. of Cracow (Poland). Inst. of Physics.
COSMOLOGY IN INTRODUCTORY COURSES OF SCIENCE - MISSED OPPORTUNITY
Zofia Golab-Meyer *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 185-190 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25059# Municipal Inst. of Education, Barcelona (Spain).
THE PLANETARIUM IN THE INTEGRATED LEARNING OF COSMOGRAHY FROM THE INITIAL CYCLE IN PRIMARY SCHOOL
Laura VanMessem *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 191-204 (For primary document see N87-25026 18-89)
Copyright Avail: NTIS HC A20/MF A01

N87-25069# Ljubljana Univ. (Yugoslavia). Dept. of Physics.
ON THE NEWTONIAN MODEL OF THE EXPANDING UNIVERSE
J. Strnad *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 255-260 (For primary document see N87-25026 18-89)
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N87-25078# Wroclaw Univ. (Poland). Inst. of Physics.
THE HIERARCHICAL STRUCTURE OF THE UNIVERSE
T. Grabinska *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 303-308 (For primary document see N87-25026 18-89)
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N87-25084# Wroclaw Univ. (Poland). Inst. of Physics.
ON PHILOSOPHICAL ASSERTIONS IN COSMOLOGY
M. Zabierowski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 333-336 (For primary document see N87-25026 18-89)
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333-336 (For primary document see N87-25026 18-89)
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N87-25085# Danish Space Research Inst., Lyngby.
ASTROPHYSICS AS AN EXAMPLE OF HOW SCIENTISTS WORK
Ib Lundgaard Rasmussen *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 337-340 (For primary document see N87-25026 18-89)
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N87-25100# Complex of Schools-Lyceum, Ostrow Wlkp (Poland).
COSMIC DISTANCE SCALES IN THE CLASSROOM
Zenon Gubanski *In* ESA Proceedings of the GIREP Conference 1986. Cosmos: An Educational Challenge Nov. 1986 p 401-402 (For primary document see N87-25026 18-89)
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91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N87-25255*# National Aeronautics and Space Administration, Washington, D.C.
ADVANCES IN PLANETARY GEOLOGY
John A. Grant, III and Susan S. Nedell Jun. 1987 437 p (NASA-TM-89871; NAS 1.15:89871) Avail: NTIS HC A19/MF A01 CSCL 03B

The surface of Mars displays a broad range of channel and valley features. There is as great a range in morphology as in scale. Some of the features of Martian geography are examined. Geomorphic mapping, crater counts on selected surfaces, and a detailed study of drainage basins are used to trace the geologic evolution of the Margaritifer Sinus Quandrangle. The layered deposits in the Valles Marineris are described in detail and the geologic processes that could have led to their formation are analyzed. For individual titles, see N87-25256 through N87-25257.

N87-25256*# National Aeronautics and Space Administration, Washington, D.C.
PART 1: THE GEOMORPHIC EVOLUTION OF EASTERN MARGARITIFER SINUS, MARS
John A. Grant, III *In its* Advances in Planetary Geology Jun. 1987 259 p (For primary document see N87-25255 18-91)
Avail: NTIS HC A19/MF A01 CSCL 03B

Geomorphic mapping, crater counts on selected surfaces, and a detailed study of drainage basins, were used to trace the geologic evolution of Margaritifer Sinus Quandrangle. The oldest dated surface covering these basins evolved during the period of intense bombardment. Since that time four resurfacing events have occurred. The first three were all of regional extent, while the fourth, occurred locally, filling basins. Valley networks, incised in the third event unit, are always buried by the fourth event unit when present. A peak in geomorphic activity occurred from 10,000 to 5000. Events during this period included the formation of Uzboi/Ladon Valles with deposition in Ladon Basin, and the formation of Samara and Parana/Loire Valles in MC19SE. Flow out of Ladon Basin and to a lesser extent Samara and Parana/Loire Valles created etched terrain at their confluence that was synchronous with initiation of Margaritifer and Iani Chaos. The range of dates for the chaos may be due to periodic collapse. The extensive, well integrted nature of Samara and Parana/Loire Valles requires the existence of a long period of favorable climatic conditions to allow their formation. Development of these two systems was probably through sapping processes. Author

N87-25257*# National Aeronautics and Space Administration, Washington, D.C.
PART 2: SEDIMENTARY GEOLOGY OF THE VALLES, MARINERIS, MARS AND ANTARCTIC DRY VALLEY LAKES
Susan S. Nedell *In its* Advances in Planetary Geology Jun. 1987 175 p (For primary document see N87-25255 18-91)
Avail: NTIS HC A19/MF A01 CSCL 03B

Detailed mapping of the layered deposits in the Valles Marineris, Mars from high-resolution Viking orbiter images revealed that they from plateaus of rhythmically layered material whose bases are in the lowest elevations of the canyon floors, and whose tops are within a few hundred meters in elevation of the surrounding plateaus. Four hypotheses for the origin of the layered deposits were considered: that they are eolian deposits; that they are remnants of the same material as the canyon walls; that they are explosive volcanic deposits; or that they were deposited in standing bodies of water. There are serious morphologic objections to each of the first three. The deposition of the layered deposits in standing bodies of water best explains their lateral continuity, horizontality, great thickness, rhythmic nature, and stratigraphic relationships with other units within the canyons. The Martian climatic history indicated that any ancient lakes were ice covered. Two methods for transporting sediment through a cover of ice on a martian lake appear to be feasible. Based on the presently available data, along with the theoretical calculations presented, it appears most likely that the layered deposits in the Valles Marineris were laid down in standing bodies of water. Author

N87-25258*# State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences.
INVESTIGATION OF LUNAR CRUSTAL STRUCTURE AND ISOSTASY Final Technical Report
Clifford H. Thurber Jul. 1987 12 p
(Grant NAGw-760)
(NASA-CR-181071; NAS 1.26:181071) Avail: NTIS HC A02/MF A01 CSCL 03B

The lunar mascon basins have strongly free air gravity anomalies, generally exceeding 100 milligals at an elevation of 100 km. The source of the anomalies is a combination of mantle uplift beneath the impact basins and subsequent infilling by high-density mare basalts. The relative contribution of these two components is still somewhat uncertain, although it is generally accepted that the amount of mantle uplift greatly exceeds the thickness of the basalts. Extensive studies have been carried out of the crustal structure of mare basins, based on gravity data, and their tectonic evolution, based on compressive and extensional tectonic features. The present study endeavored to develop a unified, self-consistent model of the lunar crust and lithosphere incorporating both gravity and tectonic constraints. Author

N87-25259*# Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.
LABORATORY EVALUATION AND APPLICATION OF MICROWAVE ABSORPTION PROPERTIES UNDER SIMULATED CONDITIONS FOR PLANETARY ATMOSPHERES Semiannual Status Report, 1 Feb. - 31 Jul. 1987
Paul G. Steffes 16 Jul. 1987 39 p
(Grant NAGw-533)
(NASA-CR-180653; NAS 1.26:180653; SASR-7) Avail: NTIS HC A03/MF A01 CSCL 03B

Laboratory measurements were conducted to evaluate properties of atmospheric gases under simulated conditions for the outer planets. A significant addition to this effort was the capability to make such measurements at millimeter wavelengths. Measurements should soon be completed on the millimeter wave absorption from ammonia under Jovian conditions. Also studied will be the feasibility of measuring the microwave and millimeter wave properties of phosphine (PH3) under simulated Jovian conditions. Further analysis and application of the laboratory results to microwave and millimeter wave absorption data for the outer planet, such as Voyager Radio Occultation experiments, will be pursued. B.G.

N87-25260 California Inst. of Tech., Pasadena.
MERIDIONAL ENERGY BALANCE OF URANUS. 2: VISCOSITY OF ROCK-ICE MIXTURES. 3: THE THERMOSPHERE OF TITAN Ph.D. Thesis
Andrew James Friedson 1987 260 p
Avail: Univ. Microfilms Order No. DA8702490

The seasonal meridional energy balance and thermal structure of the atmosphere of Uranus was investigated using a two-dimensional radiative-convective-dynamical model. Diurnal-average temperatures and heat fluxes were calculated as a function of pressure, latitude, and season. In addition to treating radiation and small-scale convection in a manner typical of conventional radiative-convective models, the dynamical heat fluxes due to large-scale baroclinic eddies are included and parametrized using a mixing length formulation. Theory and experiments are used to establish lower and upper bounds on the ratio of actual viscosity to pure ice viscosity for a suspension of rock particles in a water ice matrix. For typical conditions encountered by icy satellites, this ratio is of the order ten or possibly larger, depending on unknown factors such as the particle size distribution. The diurnal variation of the vertical structure of Titan's thermosphere is numerically calculated. The temperature and density profiles are found above the mesosphere. The vertical extent of the hydrogen cloud is too large to be explained by simple thermal escape of hydrogen from an approximately 225 K exosphere.
Dissert. Abstr.

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

N87-25261*# National Central Univ., Chung-Li (Taiwan). Center for Space and Remote Sensing Research.
SIMULATION OF JANUARY 1-7, 1978 EVENTS
J. K. Chao, M. B. Moldwin, and S.-I. Akasofu (Alaska Univ., Fairbanks.) 29 Jun. 1987 21 p
(Grant NAG5-571)
(NASA-CR-181069; NAS 1.26:181069) Avail: NTIS HC A02/MF A01 CSCL 03B

The solar wind disturbances of January 1 to 7, 1978 are reconstructed by a modeling method. First, the interplanetary magnetic field (IMF) background pattern, including a corotating shock, is reproduced using the Stanford source surface map. Then, two solar flares with their onset times on January 1, 0717 UT at S17 deg E10 deg and 2147 UT S17 deg E32 deg, respectively, are selected to generate two interplanetary transient shocks. It is shown that these two shocks interacted with the corotating shock, resulting in a series of interplanetary events observed by four spacecraft, Helios 1 and 2, IMP-8 (Interplanetary Monitoring Platform 8), and Voyager 2. Results show that these three shock waves interact and coalesce in interplanetary space such that Helios 2 and Voyager 2 observed only one shock and Helios 1 and IMP-8 observed two shocks. All shocks observed by the four spacecraft, except the corotating shock at Helios 1, are either a transient shock or a shock which is formed from coalescing of the transient shocks with the corotating shock. The method is useful in reconstructing a very complicated chain of interplanetary events observed by a number of spacecraft. Author

N87-25262# Institut d'Aeronomie Spatiale de Belgique, Brussels.
ULTRAVIOLET SOLAR IRRADIANCE MEASUREMENT FROM 200 TO 358 nm DURING SPACELAB 1 MISSION
D. Labs, H. Neckel, P. C. Simon, and G. Thuillier (Centre National de la Recherche Scientifique, Verrieres-Le Buisson, France) 1987 35 p Submitted for publication Sponsored by CNES, the Ministere de l'Education Nationale, Belgium, and the Bundesministerium fuer Forschung und Technologie
(Aeronomica-Acta-A-315-1987; ISSN-0065-3713; ETN-87-99258)
Avail: NTIS HC A03/MF A01

Results obtained from the UV-spectrometer of the Solar Spectrum Experiment during the Spacelab 1 mission are presented. The irradiance data concern 492 passbands, which are located between 200 and 358 nm at almost equidistant wavelengths separated by 0.3 nm. The passbands have a well defined, bell-shaped profile with a full width at half maximum of 1.3 nm. The data, which have an error budget between 4% and 5%, agree closely with the spectral distributions observed by Heath (1980) and Mentall et al (1981) and confirm that the solar irradiance and the fluxes of Sun-like stars show the same spectral distribution down to at least 240 nm. ESA

N87-25263 California Univ., San Diego.
NEUTRON AND 2.223 MeV GAMMA-RAY LINE EMISSION FROM SOLAR FLARES Ph.D. Thesis
Xin-Min Hua 1986 145 p
Avail: Univ. Microfilms Order No. DA8705600

Systematic calculations of the neutron and 2.223 MeV gamma-ray line production in solar flares and their escape fluxes as a function of angle, energy, and time were performed. With a connected system of Monte Carlo programs, the depth, energy and angular dependences of neutron production and their subsequent capture gamma-ray line emission in the solar atmosphere were calculated as a function of the accelerated ion energy spectrum and angular distribution, and then the attenuation of the escaping neutrons and gamma-rays were calculated as a function of energy and observing angle, or heliocentric position. The calculation also gave the time dependent 2.223 gamma-ray and neutron flux at the Earth. Comparisons of the results of these calculations with solar flare gamma ray and neutron observations have yielded important information on both the flare accelerated ions and the solar He-3 abundance.It was found that the accelerated ions trapped at the Sun have a relatively narrow range of energy spectra, which is almost identical to that of the accelerated ions observed in the interplanetary medium, implying the same acceleration process for both. Dissert. Abstr.

N87-25142# Academy of Sciences (USSR), Moscow. Inst. of Space Research.
THEORY AND OBSERVATIONS OF SOLAR WIND/COMETARY PLASMA INTERACTION PROCESSES
A. A. Galeev *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 3-17 (For primary document see N87-25141 18-90)
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N87-25151# Central Research Inst. for Physics, Budapest (Hungary).
PLAZMAG-1 EXPERIMENT: SOLAR WIND MEASUREMENTS DURING THE CLOSEST APPROACH TO COMET GIACOBINI-ZINNER BY THE ICE PROBE AND TO COMET HALLEY BY THE GIOTTO AND SUISEI SPACECRAFT
I. Apathy, A. P. Remizov, K. I. Gringauz, V. M. Balebanov, I. Szemerey, S. Szendroe, T. Gombosi, I. N. Klimenko, M. I. Verigin, E. Keppler (Academy of Sciences, USSR, Moscow) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 65-70 (For primary document see N87-25141 18-90)
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N87-25165# Ceskoslovenska Akademie Ved, Ondrejov. Inst. of Astronomy.
ANALYSIS OF SOLAR ACTIVITY DURING THE PERIOD OF HALLEY ENCOUNTER
B. Valnicek *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 157-159 (For primary document see N87-25141 18-90)
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N87-25185# Mullard Space Science Lab., Dorking (England).
SOLAR WIND FLOW THROUGH THE HALLEY BOW SHOCK
A. J. Coates, A. D. Johnstone, M. F. Thomsen, V. Formisano, E. Amata, B. Wilken, K. Jockers, J. D. Winningham, H. Borg, and D. A. Bryant (Science Research Council, Chilton, England) *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 263-268 Original contains color illustrations (For primary document see N87-25141 18-90)
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N87-25188*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CHARGE EXCHANGE OF SOLAR WIND IONS IN THE COMET HALLEY COMA
E. G. Shelley, S. A. Fuselier, J. F. Drake, H. Balsiger, Wing-H. Ip (Max-Planck-Inst. fuer Aeronomie, Katlenburg-Lindau, West Germany), B. E. Goldstein, R. Goldstein, and M. Neugebauer *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 285-289 Sponsored in cooperation with the BMFT and the Swiss National Science Foundation (For primary document see N87-25141 18-90)
(Contract NASw-3729)
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CSCL 03B

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

N87-25264*# Wisconsin Univ., Madison. Dept. of Physics.
COSMIC X-RAY PHYSICS Semiannual Status Report, 1 Jan. - 30 Jun. 1987
D. McCammon, D. P. Cox, W. L. Kraushaar, and W. T. Sanders Jul. 1987 10 p
(Grant NAG5-629)
(NASA-CR-181077; NAS 1.26:181077) Avail: NTIS HC A02/MF A01 CSCL 03B

The soft X-ray sky survey data are combined with the results from the UXT sounding rocket payload. Very strong constraints can then be placed on models of the origin of the soft diffuse background. Additional observational constraints force more complicated and realistic models. Significant progress was made in the extraction of more detailed spectral information from the UXT data set. Work was begun on a second generation proportional counter response model. The first flight of the sounding rocket will have a collimator to study the diffuse background. Author

N87-25265 Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
A SEARCH FOR X-RAY EMISSION FROM A NEARBY PULSAR: PSR 1929+10
A. Alpar, W. Brinkmann, U. Kiziloglu, H. Oegelman, and D. Pines (Illinois Univ., Urbana.) Oct. 1986 15 p Submitted for publication
(MPE-Preprint-73; ETN-87-99647) Copyright Avail: NTIS Fachinformationszentrum, Karlsruhe, West Germany

Observations of PSR 1929+10 with EXOSAT are described. In the 0.04 to 2.4 keV range a 2 sigma upper limit of 0.005 cts/sec is obtained. This translates to a luminosity upper limit of L less than or = 2 times 10 to the 29th power ergs/sec for a power-law source with photon number index = 1 to 3, and L less than or = 10 to the 30th power ergs/sec corresponding to T less than or = 190,000 K for a blackbody with radius 10 km. Constraints on the energy dissipation rate inside the neutron star,

on polar cap heating, and on the possibility of a compact synchrotron nebula, as well as the consistency of the present upper limits with a previous Einstein Observatory detection are discussed. ESA

N87-25266 Max-Planck-Inst. fuer Physik und Astrophysik, Garching (West Germany). Inst. fuer Extraterrestrische Physik.
EXOSAT OBSERVATIONS OF 4U1705-44: TYPE 1 BURSTS AND PERSISTENT EMISSION
A. Langmeier, M. Sztajno, G. Hasinger, and J. Truemper Nov. 1986 15 p Submitted for publication
(MPE-Preprint-77; ETN-87-99648) Copyright Avail: NTIS Fachinformationszentrum, Karlsruhe, West Germany

Observations of the bright galactic X-ray source 4U1705-44 by EXOSAT showed that persistent emission varied from 1.3 to 10.7 times 10 to the minus 9th power ergs/sq cm/sec in the 1 to 20 keV energy band. During low intensity observations 23 type-1 X-ray bursts were detected. Three of the bursts were observed within only 5 to 18 min after a preceeding burst. Burst activity is anticorrelated with source intensity. At minimum flux 4U1705-44 is bursting at a nearly constant frequency of 0.5/hr. In a medium intensity state the burst rate decreases. No burst was detected in the maximum intensity state. Average burst flux is 15 times 10 to the minus 9th power ergs/sq cm/sec, comparable to the maximum observed flux to the persistent emission. The spectrum during maximum is best fitted by a two component model, a blackbody together with a Boltzman-Wien law and an additional iron K emission line. At minimum intensity the spectrum becomes drastically harder and is best represented by a power-law with an indication of an iron absorption edge at 8 keV. ESA

N87-25144# Mullard Space Science Lab., Dorking (England).
VARIATIONS IN THE SOLAR WIND FLOW DURING THE APPROACH TO COMET HALLEY
A. D. Johnstone, A. J. Coates, J. Heath, M. F. Thomsen, B. Wilken, K. Jockers, V. Formisano, E. Amata, J. D. Winningham, H. Borg (Kiruna Geophysical Inst., Sweden) et al. *In* ESA Proceedings of the 20th ESLAB Symposium on the Exploration of Halley's Comet. Volume 1: Plasma and Gas Dec. 1986 p 25-27 (For primary document see N87-25141 18-90)
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99 GENERAL

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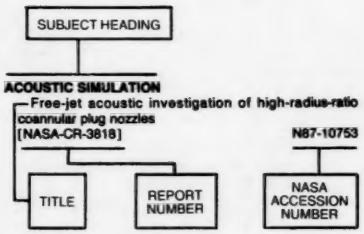

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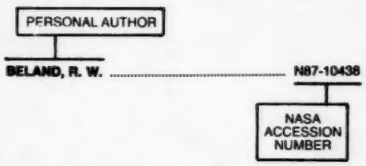

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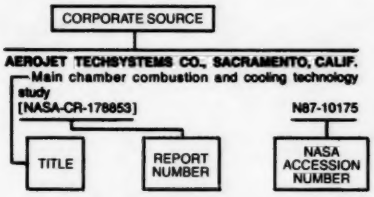

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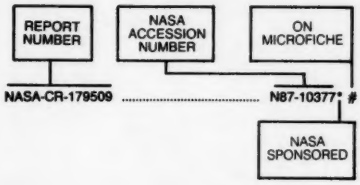

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